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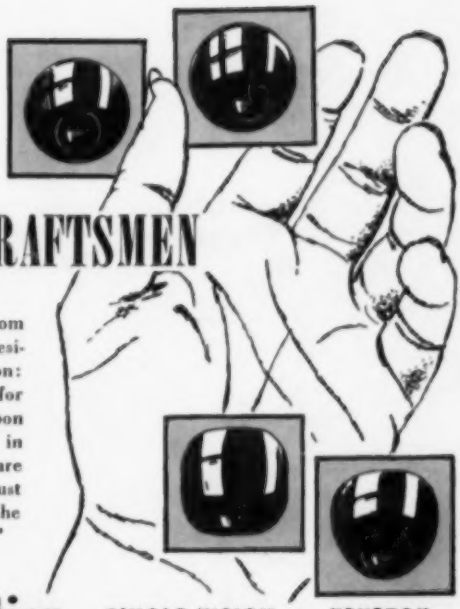

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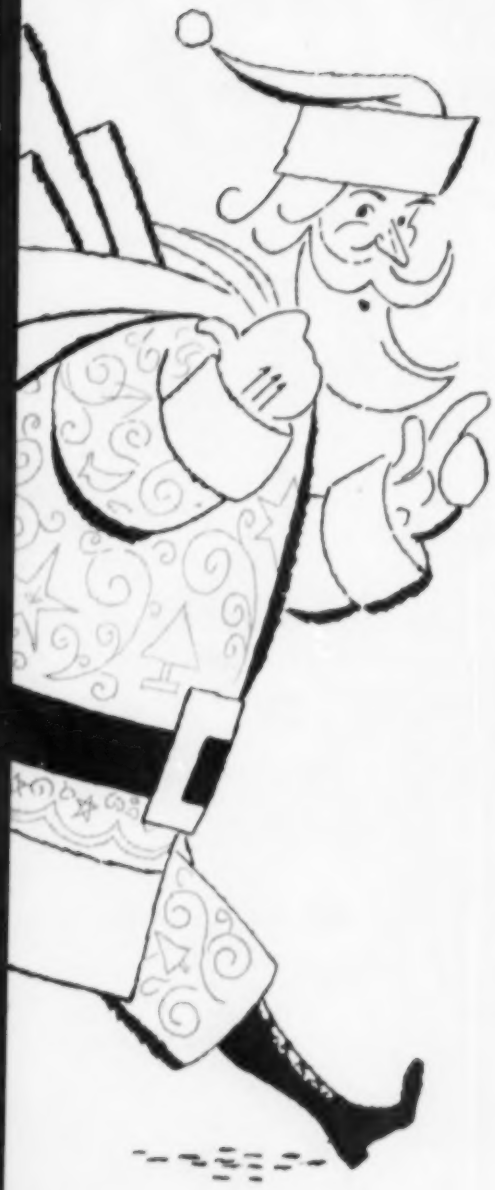

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Vol. 32 December, 1955 No. 12

A QUANTITATIVE INVESTIGATION OF THE MARCUS-GUNN PHENOMENON*

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The present investigation was carried out so that some insight might be gained into the neuro-physiological basis of the Jaw-Winking or Marcus-Gunn Phenomenon.[1, 3] The typical jaw winker has, when at rest what appears to be a paresis of the levator of one eye only[1] resulting in monolateral ptosis (Figure 1). Associated with the ptosis there is often a paresis of the elevators of the same eye.[2] The subject is unable to voluntarily raise the ptotic lid, but when the jaw is moved down[1, 3] or down and to the opposite side[1, 3] from the ptosis the lid momentarily retracts (Figures 2, 3). The lid remains elevated momentarily but soon slides down to its original ptotic position[3] even though the jaws are kept open. The ptotic lid sometimes retracts upon swallowing[1, 3] (Figure 5), passively closing the opposite lid[3] (Figure 6) or sucking[1, 3] (Figure 7). In fact the phenomenon is often first noticed in the suckling baby.[3]

It was also noted that there was a paradoxical lid retraction on depression of the eyes. This has been noticed by the author in two different patients with the Marcus-Gunn Syndrome. The first had a complete ptosis and on depression of the eyes there was a slight elevation of the ptotic lid. The second case had a partial ptosis and on depression of the eyes, the ptotic lid lagged behind the normal lid.

A routine refraction was carried out resulting in the following prescription:

OD. $+3.50 \bigcirc -4.75 \times 15$ V.A. 20/20.
OS: $+3.50 \bigcirc -4.50 \times 155$ V.A. 20/30.

Figure 13 shows that there is no apparent tropia when the eyes are in the primary plane of regard and directed towards a distant fixation point located on the mid-sagittal plane. Figures 15 and 17 show that there is no apparent tropia when the eyes are in the lower half of the field of fixation.

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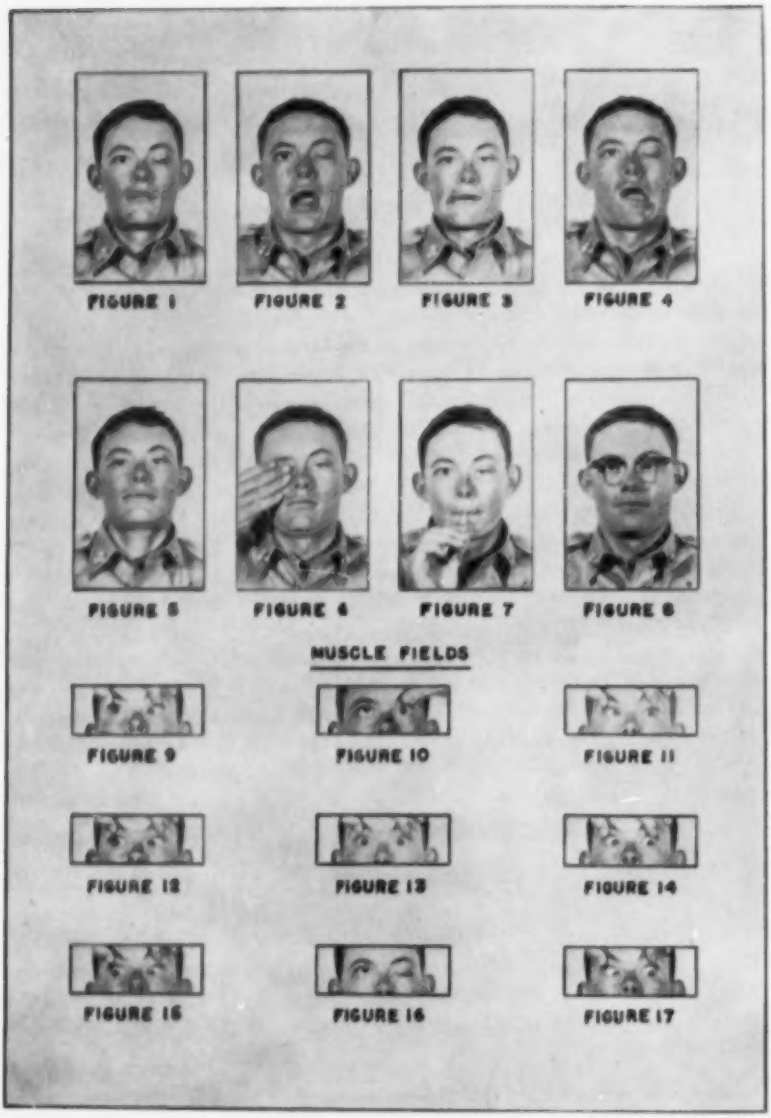

Fig. 1. Normal appearance of the subject, showing ptosis of the left lid, with inability to voluntarily open the eye.
Fig. 2. Movement of jaw downward, showing the associated retraction of the left lid.

The degree of binocular vision was determined by the use of the Worth 4-Dot test and the red lens test. It was demonstrated that there was complete central suppression of the left eye.

A detailed study was made of the motor functions of the extra ocular muscles. It was determined that the levator of the left eye would not respond to direct voluntary stimulation, but would respond to swallowing and suckling reflexes. The act of swallowing is a complicated reflex movement which may be initiated voluntarily, but is for the most part quite independent of the will. It arises from a brain stem center which has afferent components from the cerebrum, as well as the sensory fibers to the mucous membrane of the pharynx and esophagus, including branches of the glossopharyngeal, trigeminal, vagus and superior laryngeal division of the vagus.[4] The motor components concerned in this reflex are comprised of the hypoglossal, trigeminal, glossopharyngeal, vagus and the spinal accessory nerves.[4]

It was then determined that the levator would contract when the jaw was moved down or down and to the opposite side. These two movements are carried out by the contraction of the external pterygoid muscles[5] which are innervated by the mesencephalic root of the trigeminal nerve.[5] Opening of the jaw is performed primarily by the two external pterygoid muscles pulling forward on the condyles and rotating the mandible about the center of rotation near the angle. They are assisted at the beginning of the action by the mylohyoideus, digastricus, and geniohyoideus. If the external pterygoid of one side acts, the corresponding side of the mandible is drawn forward while the opposite condyle remains comparatively fixed. Thus, if one desires

Fig. 3. Movement of the jaw down and to the right, showing the associated retraction of the left lid.
Fig. 4. Movement of the jaw down and to the left, showing that there is no associated retraction of the left lid.
Fig. 5. Swallowing, showing the associated retraction of the left lid.
Fig. 6. Pulling the right lid down, showing the associated retraction of the left lid.
Fig. 7. Exaggerated sucking, showing the associated retraction of the left lid.
Fig. 8. Ptosis crutch designed and fabricated by Capt. Milton Braveman, Optometry Officer, U. S. Army Hospital, Fort Jackson, S. C.
Fig. 9. Gaze directed up and to the right, showing paralysis of the left inferior oblique.
Fig. 10. Gaze directed upward, showing absence of elevation of the left eye.
Fig. 11. Gaze directed up and to the left, showing paralysis of the left superior rectus.
Fig. 12. Gaze directed to the right. Note the overaction of the left superior oblique resulting in a left hypotropia.
Fig. 13. Gaze directed at a distant target located in the primary plane of regard.
Fig. 14. Gaze directed to the left. Note the overaction of the left inferior rectus resulting in a left hypotropia.
Fig. 15. Gaze directed down and to the right, showing that there is no apparent tropia.
Fig. 16. Gaze directed upward, showing the absence of any lid retraction of the left eye associated with upward gaze.
Fig. 17. Gaze directed down and to the left, showing that there is no apparent tropia.

to move his jaw down and to the right, it involves mainly the contraction of the left external pterygoid muscle.

Finally, it was demonstrated that the levator would contract when the lid of the opposite eye was passively closed. This can be explained by a stretch reflex. Thus, when the right lid is pulled down, there is a stretch reflex initiated which tends to elevate both eyelids. However, since the left eyelid is the only freely moving lid, it elevates. The first division of the fifth nerve and possibly a portion of the third and seventh nerves would contain afferent fibers and the third nerve the motor fibers. This stretch reflex is probably normally inhibited by the higher centers and only manifests itself under special conditions. (See summary.)

The muscle fields (Figures 9-17) showed that there was an involvement of the left superior rectus (L.S.R.) and the left inferior oblique (L.I.O.). To explain this as a nuclear involvement[6, 7] is difficult for it would be almost impossible to obtain a nuclear lesion which would not involve the other muscles innervated by the third nerve. However, a cerebral or supra-nuclear lesion[6, 7] does not explain the findings, for this involvement is monolateral and the above lesions result in bilateral involvement. It was noted on forced closure of the eyelids that there was a demonstration of Bell's Phenomenon in both eyes, which is conclusive evidence that the nucleus is intact.[5] However, *where is the lesion?*

The following experiments were carried out to gain some insight into the location of the lesion affecting the involved muscles:

a. The pupil response was checked and found to react directly and consensually to light. There was a normal pupil response to accommodation and convergence. In all cases the speed of the pupil responses were equal and there was no anisocoria.

b. The equality of accommodation in the two eyes was verified by a direct method involving a dynamic skiametry technique (Figure 18). A near point card (Figure 18-A) consisting of 20/30 letters mounted just below a one-inch aperture was placed on the reading rod at a distance of forty centimeters from the spectacle plane. The subject viewed the target binocularly and was instructed to keep the letters clear at all times. With this technique one could observe the retinoscopy reflex of either eye through the small aperture. In the typical case "with motion" is observed if one scopes in the same plane as the target. However, if one moves back from the target one will reach the "neutral point" and finally "against motion." The neutral point, P_1, was determined five times for each eye, and the average and

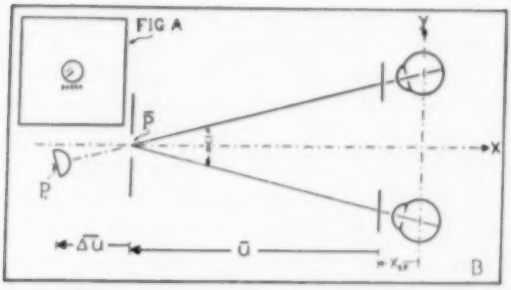

Fig. 18. Skiametric technique used in the evaluation of the magnitude of accommodation in the two eyes. A. Front view of the reading card showing the position of the letters and the aperture. B. The subject fixates the line of letters which are mounted on a reading card placed at the fixation point, $\overline{P}$. The neutral point is determined by moving the skiascope along the primary line of sight of the respective eye and the position ($\Delta u_1 + \bar{u}$) of P_1 is noted. Then P_2 is determined for the other eye.

The Equation $\left(\frac{1}{\Delta u_1 + \bar{u}} - \frac{1}{\Delta u_2 + \bar{u}} = \Delta D\right)$ gives an index of the difference in accommodation between the two eyes. The equation becomes more involved in cases of anisometropia.

range of the positions were calculated. It was statistically found that there was less than a quarter diopter difference in accommodation between the two eyes. This test was repeated at a five diopter stimulus level and essentially the same results were obtained. This is conclusive evidence that there is no involvement of the accommodative mechanism of the left eye.

c. Targets were placed in the nine cardinal positions and the subject voluntarily looked in each designated direction, first with each eye independently and binocularly. There was no elevation of the left eye indicating an involvement of the L.S.R. and the L.I.O.

d. The muscle fields were repeated using a moving target, thus testing the pursuit movements. There was no elevation of the left eye.

e. In the normal subject there is an associated elevation of the lids in upward gaze of the eyes. Figure 16 shows that there is not the slightest elevation of the left lid during upward gaze in this case.

f. On forced closure of the lid there was an upward movement of the left eye which is a demonstration of Bell's Phenomenon.[6, 7] This bit of evidence showed that the lesion is not nuclear in origin.

g. The semi-circular canals were stimulated by using the Barany Chair technique.[8, 9] Vertical nystagmus was elicited in both eyes, and it was demonstrated that the left eye moved upward. The nystagmus appeared of equal magnitude in both eyes, and the direction of the fast

and slow component was induced in both directions, depending upon the stimulus situation used.[9]

b. The subject was seen by the neurological service and a very complete neurological examination was carried out. There were no other anomalies.

From the above facts it can be conclusively stated that:

a. Even though the left eye does not respond to voluntary elevation, the lesion is not in the frontal lobe because the apparent paresis is monolateral.

b. Even though the left eye does not respond to elevatory pursuit movements, the lesion is not in the occipital lobe because the paresis is monolateral.

c. The lesion cannot be in the center for vertical gaze which is located in the superior colliculus, because it would result in a bilateral involvement.

d. The medial longitudinal fasciculus (M.L.F.) is not involved for:

(1) There is no impairment of lateral gaze which is subserved by fibers running from the pontine centers for lateral gaze through the M.L.F. to the third nuclei.

(2) There is no involvement of induced vestibular nystagmus which is subserved by fibers running from the vestibular nuclei through the M.L.F. to the ocular motor nuclei.[6, 7]

(3) There is a normal Bell's Phenomenon. This phenomenon is thought to be either subserved by fibers running directly from the seventh nerve nuclei through the M.L.F. to the ocular motor nuclei.[6, 7] or through a brain stem center for vertical gaze and then through the M.L.F. to the ocular motor nuclei.[6, 7]

This apparent involvement of the elevators of the left eye could be accounted for by postulating a lesion (Figure 19-A) involving fibers running from the center for vertical gaze located in the superior colliculus[6, 7] to the third nerve nucleus. Such a lesion would be located near the aqueduct of Sylvius on the left side at the level of the third nerve nucleus. If this were true, it would mean that both the fibers controlling voluntary elevation of the eyes arising in the frontal lobe, and those controlling vertical pursuit movements arising in the occipital lobe are subserved by one common supranuclear center for vertical gaze. Such a lesion would also be compatible with the monolateral ptosis, for it is believed that the supranuclear center controlling the elevation of the lid is closely related to the supranuclear center subserving vertical gaze.[6, 7]

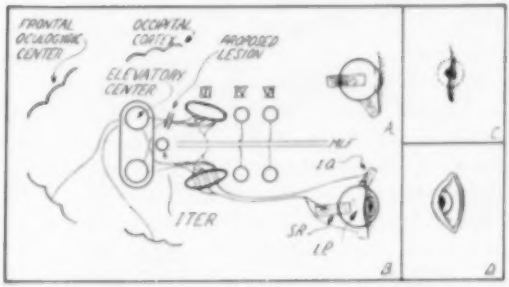

Fig. 19. The neurological organization for conjugate vertical gaze. A. Shows the location of the proposed lesion. B. Shows the normal pathways subserving conjugate vertical gaze. C. and D. Shows the position of the eyes when these pathways are stimulated. Note that the right eye has normal elevation of the eyeball and lid retraction while the left eye has ptosis and absence of elevation of the eyeball.

This lesion is also compatible with a normal Bell's Phenomenon and no interference with induced vestibular nystagmus.[6, 7]

It is also quite likely that normally the supranuclear center for vertical gaze and its associated cerebral centers exhibit inhibitory influences upon the lower order reflexes impinging on the ocular motor nuclei, thus masking their effect. This postulated lesion could also involve these inhibitory fibers, thus freeing the lower order reflexes from their influences.

It can be demonstrated[10] that when one wants to remove a foreign body from a subject's eye, it is more difficult for the subject to blink his eyes if he opens his jaw wide. Thus, this jaw opening mechanism tends to reflexively keep the lids open.

It also might be noted that if one closes his eyes and makes an exaggerated sucking reflex, there is a drawing around the eyes as if the lids want to open. This is beautifully demonstrated on a newborn child suckling his bottle. His lids are often fully elevated and the eyeballs may even rotate up under the lids, as in Bell's Phenomenon. The same phenomenon is noted in certain neurological disorders, where a tongue blade is placed in the patient's mouth, eliciting a suckling reflex and the eyes open wide. This associated reflex is inborn and one of the first to be noted in the newborn. Carmichael[11] points out that the suckling reflex, along with breathing and crawling, is one of the earliest responses evidenced in some mammals. He states that these are responses of the sort that involve proprioceptive stimulation and control.[11] Now, if we have a loss of the inhibitory impulses coming from the cerebrum and from the center for vertical gaze impinging upon the

ocular motor nuclei, then the lower order reflexes which are released from these influences become exaggerated on the side of the lesion. Thus, the phenomenon associated with Marcus-Gunn Phenomenon can be explained on normal, well established neuro-physiological principles. The timing of the lid movement and the fact that it only remains elevated for a few seconds is easily explained in that these reflexes are much like the typical stretch reflexes.

It is interesting to note that even though there is no voluntary elevation of the left eye, there is a normal elevatory fast nystagmus component associated with proper vestibular stimulation. This adds more evidence to Lorento de No's theory,[12] in which he states that vestibular nystagmus is a rhythmic reflex similar to the stretch reflex. When the semi-circular canals are stimulated, the primary vestibular nuclei discharge a continuous series of impulses which reach not only the extra ocular muscle nuclei causing the slow component, but also certain neurons in the brain stem. The neurons of this center discharge intermittently, being refractory until the vestibular impulses build up the threshold excitatory state by the process of recruitment. Thus, with each discharge of impulses from these neurons, a quick reversal of the slow phase is produced.

Since there is a normal Bell's Phenomenon, it must be assumed that this vertical eye movement is not subserved by the center for vertical gaze located in the superior colliculus. It is quite likely that it is subserved by a portion of the vestibular nucleus, probably closely associated with the portion responsible for vertical nystagmus of vestibular origin.

The Marcus-Gunn or Jaw Winking Phenomenon is usually attributed to an anomalous connection[1, 3] between the motor nuclei of the external pterygoid which is innervated by the mesencephalic root of the fifth nerve and the levator which is innervated by the third nerve. Thus, it is similar to the Pseudo-Graefe Phenomenon[1] excepting that the former is an aberrant hookup in the central nervous system while the latter is a peripheral aberrant hookup.

There are two facts which make the theory unlikely:

a. First, the apparent ptotic lid does not remain open, even after it elevates. If this phenomenon were due to an aberrant hookup between the mesencephalic portion of the fifth nerve and the third nerve, it would seem likely that since the jaw is maintained open by an asynchronous discharge of impulses bombarding the external pterygoid muscle, then there would also be an asynchronous discharge of impulses bombarding the levator, thus maintaining its elevated position. However, since the lid only momentarily retracts, and then slides down to its ptotic posi-

tion, it must mean that the contraction is mainly due to a volley of impulses, quite similar to those involved in the patellar reflex.

b. Secondly, according to the reviewed literature this Jaw Winking Phenomenon is always associated with a monolateral ptosis and never with normal lid movements.

SUMMARY

The author advances a pseudo-ophthalmoplegic explanation of the Marcus-Gunn Syndrome based on a theoretical monolateral brain stem lesion which cuts off the fibers running from the center subserving vertical gaze to the ocular motor nuclei (Figure 19-A). Such a lesion removes the inhibitory influences from the higher centers, thus exaggerating the lower order reflexes. The timing of the lid movement is explained on the same principles as those involved in a stretch reflex.

This investigation shows evidence in support of the theory[12] that the fast component of vestibular nystagmus has a brain stem origin, and is not of frontal lobe origin, as is the fast component of opticokinetic nystagmus.

There is also evidence which points to the fact that the vertical eye movement in Bell's Phenomenon is not subserved by the center for vertical gaze located in the superior colliculus. It could be closely associated with the same center which subserves the vertical movements in vestibular nystagmus.

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THE EFFECT OF FIXATION DISTANCE AND THE A.C.A. RATIO ON THE ANGLE OF ANOMALY*

PART I

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The foveae of individuals with normal binocular vision have a common visual direction. Images of an object, or objects, stimulating the foveae of such individuals are perceptually interpreted as arising in the same direction from the self, even though the foveal lines of a sight may not be directed to the same point in space. Non-foveal retinal areas, localized with respect to the fovea, also have common visual directions with similarly located retinal areas in the other eye. This forms the basis of the horopter. The above conditions are requisites of normal correspondence.

Individuals with normal binocular vision employ four types of vergence movements in obtaining and/or maintaining bifoveal fixation. These four vergence movements are:

1. *Tonic convergence*—that convergence induced by the tonicity of the extraocular muscles; it is responsible for moving the eyes from a position of rest to a fusion free position under conditions of infinity fixation and natural or artificial emmetropia.

2. *Fusional convergence*—that vergence independent of reflex association with accommodation, which may be induced to obtain and/or maintain clear single binocular vision, that is, to permit sensory fusion in normal corresponding areas.

3. *Accommodative convergence*—that convergence reflexly induced by changes in accommodative response.

4. *Proximal convergence*—that convergence induced by the apparent nearness of the object of fixation.

In normal binocular vision the amount of fusional convergence employed depends upon the distance of fixation, the interpupillary distance, the A.C.A. ratio (the amount of convergence change produced by one diopter change in accommodative response), the amount of tonic convergence present and the amount of proximal convergence present.

*Read before the annual meeting of the American Academy of Optometry, Toronto, Ontario, Canada, December 11, 1954. For publication in the December, 1955, issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.

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Fusional convergence completes bifoveal fixation by increasing or decreasing the vergence lacking or in excess of that demanded by the fixation distance.

In strabismus, where bifoveal fixation of an object simultaneously visible to both eyes is not present, the image of the object of fixation stimulates the fovea of one eye and a non-foveal area in the other eye. The image of a non-fixated object in the field of vision stimulates the fovea of the deviating eye. If normal correspondence is present, and no adaptive changes have yet occurred, diplopia for the object of fixation is present, and confusion exists due to the stimulation of the foveae by dissimilar objects interpreted as originating from the same direction in space.

Various adaptive changes may take place to eliminate this diplopia and confusion. If normal correspondence is maintained, suppression may occur in the deviating eye for both the foveal area and the peripheral area stimulated by the image of the object of fixation. Another adaptation possible is the establishment of a condition of anomalous correspondence wherein a new pattern of directionalization occurs. The foveae no longer have common visual direction. Some area in the deviating eye now functions directionally with the fovea of the fixating eye in binocular vision, this area may be termed the *anomalous associate-d area*. The fovea ceases to be the point of reference for the division of the retina into superior, inferior, nasal, and temporal halves. The anomalous associated area of the deviating eye becomes this point and directionalization of other retinal points, including the fovea, shifts in relation to it.[9]

If the anomalous associated area is so situated in the retina as to receive the image of the object of fixation, the condition is classified as *harmonious anomalous correspondence*. Here the angle of anomaly† equals the objective angle* and the subjective angle‡ would be zero.

If the anomalous associated area is not located as described above but located between this position and the fovea, the condition is classified as *unharmonious anomalous correspondence*. Here the angle of anomaly does not equal the objective angle and the subjective angle would be significantly greater than zero.

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†The angle between the line of visual direction of the fovea and the line of visual direction of the anomalous associated area subtended at the center of rotation of the deviating eye.

*The angle by which the foveal line of sight of the deviating eye fails to intersect the point of fixation subtended at the center of rotation of the deviating eye.

‡The angle through which a haploscopic target viewed by the non-fixating eye must be moved from the ortho setting for superimposition to occur, subtended at the center of rotation of the deviating eye.

Haronious anomalous correspondence would appear to be a very logical adaptive process while unharmonious anomalous correspondence would not. The manner in which unharmonious anomalous correspondence develops, providing that it does develop, has caused much speculation on the part of many authorities.[1, 2, 3, 4, 5] To add to the perplexity, unharmonious anomalous correspondence has been found more frequently when measurements of the various angles were made on an amblyoscope than when measurements were made under more nearly normal seeing conditions.[6, 7, 8] The above points will be considered in greater detail later in this paper.

Since binocular fixation is not present in strabismus, fusional convergence, as it has been defined, also is not present. Tonic convergence and accommodative convergence are present, while the presence or absence of proximal convergence has not been established.

In normal correspondence the objective and subjective angles should be equal for any fixation distance. The angles should change equally with the amount of accommodative convergence involved. Many patients, however, show a constant subjective angle, i.e., an apparent A.C.A. ratio of six, but a changing objective angle with changing testing distance. Thus at near the objective and subjective angles may no longer be equal. This difference between near-point measurements of the objective and subjective angles in patients with normal correspondence would appear paradoxical since the foveae retain common visual direction. An explanation of this apparently contradictory situation would be afforded if the deviating eye in binocular vision maintained such a position relative to the fixating eye that the image of the fixated object always fell in the same peripheral area of suppression through a *suppression movement*, so to speak, analogous to the fusional vergence movement. Thus even though an A.C.A. ratio other than six exists, this suppression movement would compensate for the difference. If this were true, such a suppression movement may not occur in testing the objective angle as with alternate fixation at some near distance, but may return when binocular vision is restored, as does fusional vergence in non-strabismic patients after the completion of phoria measurements by the alternate fixation method.

If gradients be determined for these patients which demonstrate apparent A.C.A. ratios of six, as determined by comparing far and near point subjective angles, it is frequently found that the gradient values are zero or relatively small, especially if the measurements are made prior to visual training and under relatively normal seeing conditions. The suppression movement suggested above would explain this apparent

paradoxical situation and the difficulties encountered in attempting to obtain valid gradient measurements on strabismics. Thus changes in convergence due to changes in accommodation, from the addition of concave or convex lenses before the eyes, may be nullified or reduced by this suppression movement. It is known that if prisms are prescribed for a suppressing strabismic intended wholly or partially to correct the objective angle, in a relatively short time the objective angle and subjective angle increase by an amount approximating the prism power This response is usually considered a movement to restore the image to the existing suppression area. This can be interpreted as a suppression movement to counteract the prism effects. If a suppression movement does occur in counteracting prism effects, its presence in counteracting lens effects would not be surprising.

If the suppression movement is present and operative with changes in fixation distance to relatively close points, the crossing point of the visual axes in esotropes could not be reached. From clinical observation, however, in the cases demonstrating apparent A.C.A. ratios of six, this crossing point is reached, the subjective and objective angles becoming progressively smaller as this point is approached. Thus it may be reasoned that convergence has reached a physiological limit and lags behind the demand, as may accommodation, and the suppression movement breaks down.

If a suppression movement does not exist and accommodative convergence changes are not compensated for, in cases of normal correspondence, then it may be assumed that either a large area of suppression exists, making this movement unnecessary, or the retinal location of the area of suppression is a variable one and shifts with the fixation distance and the A.C.A. ratio.

In cases of anomalous correspondence other factors are present and must be considered. This refers especially to the anomalous associated area and the change in visual direction with reference to specific retinal points.

The question arises, what effect does the fixation distance and the A.C.A. ratio have on the retinal location of the anomalous associated area. Theoretically three possibilities present themselves.

1. The angle of anomaly remains constant and the anomalous associated area is stimulated constantly by means of an *anomalous fusional movement*, similar to the normal fusional vergence movement. (See Figure 1 and Tables 1, 2 and 3.) This movement would be required if the A.C.A. ratio is other than 6, and would give apparent A.C.A. ratios of 6 if subjective angles at different fixation distances

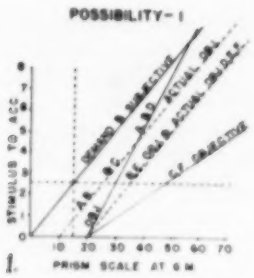


TABLE 1.

Examples of Expected Findings for Possibility—1. Anomalous Fusional Movement Present—Angle of Anomaly Contant—Subj. Angle = Zero—Obj. Angle Varying With the A.C.A. Ratio as Measured.

A. Given: A.C.A. = 4
P.D. = 60
Objective Angle Measured = 20 B.O.
Subjective Angle Measured = 10 B.O.
Angle of Anomaly = 10 B.O.

Distance	Conv. Demand	Obj. Ang. M.	Obj. Ang. A.	Total Conv.—Obj.	Subj. An. M.	Subj. An. A.	Subj. Conv.	An. of Anom.
Infinity	0	20	10	20	10	0	0	10
40 CM.	15	15	10	30	5	0	15	10
20 CM.	30	10	10	40	0	0	30	10

B. Given: A.C.A. = 6
P.D. = 60
Objective Angle = 20 B.O. (Measured)
Subjective Angle = 10 B.O. (Measured)
Angle of Anomaly = 10 B.O.

Distance	Conv. Demand	Obj. Ang. M.	Obj. Ang. A.	Total Conv.—Obj.	Subj. An. M.	Subj. An. A.	Subj. Conv.	An. of Anom.
Infinity	0	20	10	20	10	0	0	10
40 CM.	15	20	10	35	16	0	15	10
20 CM.	30	20	10	50	10	0	30	10

are compared. It implies that the subjective angle remains constant although the objective angle may vary.

2. The angle of anomaly varies directly with the A.C.A. ratio and fixation distance. (See Figures 2, 3, 4 and 5, and Tables 4, 5, 6, and 7.) The subjective angle would remain constant and the objective angle and the angle of anomaly would be covariants of equal amount in both harmonious and unharmonious anomalous correspondence (here no anomalous fusional movement is necessary). An alternate possibility in unharmonious anomalous correspondence would be that the subjective angle and the angle of anomaly would be covariants of equal amount and the objective angle would vary and be equal to the sum of the angles. (See Figures 6, 7 and 8, and Tables 8 and 9.)

TABLE 2.

Examples of Expected Findings for Possibility—1. Anomalous Fusional Movement Present—Angle of Anomaly Constant—Subj. Angle = Zero.—Obj. Angle Varying With the A.C.A. Ratio as Measured.

C. Given: A.C.A. = 8
P.D. = 60
Objective Angle = 20 B.O. (Measured)
Subjective Angle = 10 B.O. (Measured)
Angle of Anomaly = 10 B.O.

Distance	Conv. Demand	Obj. Ang. M.	Obj. Ang. A.	Total Conv.—Obj.	Subj. An. M.	Subj. An. A.	Subj. Conv.	An. of Anom.
Infinity	0	20	10	20	10	0	0	10
40 CM.	15	25	10	40	15	0	15	10
20 CM.	30	30	10	60	20	0	30	10

D. Given: A.C.A. = 4
P.D. = 60
Objective Angle = 20 B.O. at Infinity
Subjective Angle = 0
Angle of Anomaly = 20 B.O.

Distance	Conv. Demand	Obj. Ang. M.	Obj. Ang. A.	Total Conv.—Obj.	Subj. An. M.	Subj. An. A.	Subj. Conv.	An. of Anom.
Infinity	0	20	20	20	0	0	0	20
40 CM.	15	15	20	30	— 5	0	15	20
20 CM.	30	10	20	40	—10	0	30	20

TABLE 3.

Examples of Expected Findings for Possibility—1. Anomalous Fusional Movement Present—Angle of Anomaly Constant—Subj. Angle = 0.—Obj. Angle Varying With the A.C.A. Ratio as Measured.

E. Given: A.C.A. = 6
P.D. = 60
Objective Angle = 20 B.O. at Infinity
Subjective Angle = 0
Angle of Anomaly = 20 B.O.

Distance	Conv. Demand	Obj. Ang. M.	Obj. Ang. A.	Total Conv.—Obj.	Subj. An. M.	Subj. An. A.	Subj. Conv.	An. of Anom.
Infinity	0	20	20	20	0	0	0	20
40 CM.	15	20	20	35	0	0	15	20
20 CM.	30	20	20	50	0	0	30	20

F. Given: A.C.A. = 8
P.D. = 60
Objective Angle = 20 B.O. at Infinity
Subjective Angle = 0
Angle of Anomaly = 20 B.O.

Distance	Conv. Demand	Obj. Ang. M.	Obj. Ang. A.	Total Conv.—Obj.	Subj. An. M.	Subj. An. A.	Subj. Conv.	An. of Anom.
Distance	0	20	20	20	0	0	0	20
40 CM.	15	25	20	40	5	0	15	20
20 CM.	30	30	20	60	10	0	30	20

3. The angle of anomaly is constant and the subjective and objective angles are covariants. (See Figures 9, 10, 11, 12, 13 and 14, and Tables 10, 11 and 12.) Here an anomalous fusional movement would not be present.

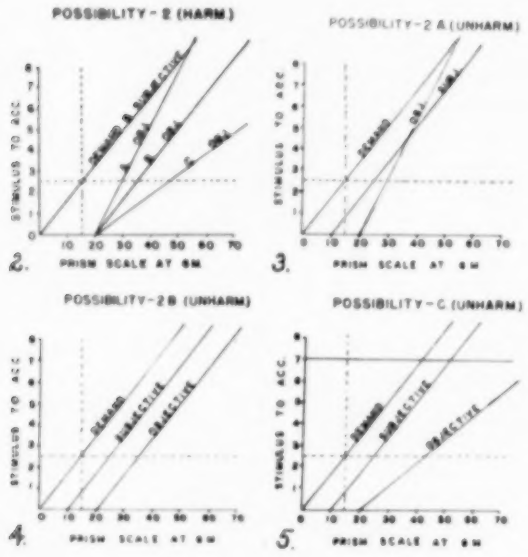


TABLE 4.

Examples of Expected Findings for Poss.—2. Angle of Anomaly and Objective Angle Varying Directly with A.C.A. Ratio and Fixation Distance. Subjective Angle = 0. —Harmonious Anom. Correspondence.

A. Given: A.C.A. = 4
P.D. = 60
Objective Angle = 20 B.O. at Infinity
Subjective Angle = 0
Angle of Anomaly = 20 B.O. at Infinity

Distance	Conv. Demand	Obj. Ang.	Total Conv. Objective	Subj. Ang.	Subj. Conv.	An. of Anom.
Infinity	0	20	20	0	0	20
40 CM.	15	15	30	0	15	15
20 CM.	30	10	40	0	10	10

B. Given: A.C.A. = 6
P.D. = 60
Objective Angle = 20 B.O. at Infinity
Subjective Angle = 0
Angle of Anomaly = 20 B.O. at Infinity

Distance	Conv. Demand	Obj. Ang.	Total Conv. Objective	Subj. Ang.	Subj. Conv.	An. of Anom.
Infinity	0	20	20	0	0	20
40 CM.	15	20	35	0	15	20
20 CM.	30	20	50	0	30	20

The first possibility would appear more likely in cases of harmonious anomalous correspondence but some question may be raised concerning its presence in unharmonious anomalous correspondence.

TABLE 5.

Examples of Expected Findings for Poss.—2. Angle of Anomaly and Objective Angle Varying Directly with A.C.A. Ratio and Fixation Distance. Subject Angle = 0.—Harmonious Anomalous Correspondence.

C. Given: A.C.A. = 8 Harmonious Anom. Corresp.
P.D. = 60
Objective Angle = 20 B.O. at Infinity
Subjective Angle = 0
Angle of Anomaly = 20 B.O. at Infinity

Distance	Conv. Demand	Obj. Ang.	Total Conv. Objective	Subj. Ang.	Subj. Conv.	An. of Anom.
Infinity	0	20	20	0	0	20
40 CM.	15	25	40	0	15	25
20 CM.	30	30	60	0	30	30

TABLE 6.

Examples of Possibility—2. Unharmon. Anomalous Correspondence—Angle of Anomaly and Objective Angle Varying Directly with A.C.A. Ratio and Fixation Dist.—Subjective Angle Remains Constant.

A. Given: A.C.A. = 4
P.D. = 60
Objective Angle = 20 B.O. at Infinity
Subjective Angle = 10 B.O. at Infinity
Angle of Anomaly = 10 B.O. at Infinity

Distance	Conv. Demand	Obj. Ang.	Total Conv. Objective	Subj. Ang.	Subj. Conv.	An. of Anom.
Infinity	0	20	20	10	10	10
40 CM.	15	15	30	10	25	5
20 CM.	30	10	40	10	40	0

B. Given: A.C.A. = 6
P.D. = 60
Objective Angle = 20 B.O. at Infinity
Subjective Angle = 10 B.O. at Infinity
Angle of Anomaly = 10 B.O. at Infinity

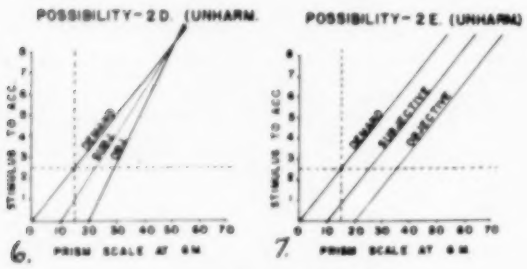
Distance	Conv. Demand	Obj. Ang.	Total Conv. Objective	Subj. Ang.	Subj. Conv.	An. of Anom.
Infinity	0	20	20	10	10	10
40 CM.	15	20	35	10	25	10
20 CM.	30	20	50	10	40	10

TABLE 7.

Examples of Possibility—2. Angle of Anomaly and Objective Angle Varying Directly With the A.C.A. Ratio and Fixation. Dist., Subj. Angle Remaining Constant.—Unharmon. Anom. Correspondence.

C. Given: A.C.A. = 8
P.D. = 60
Objective Angle = 20 B.O. at Infinity
Subjective Angle = 10 B.O. at Infinity
Angle of Anomaly = 10 B.O. at Infinity

Distance	Conv. Demand	Obj. Ang.	Total Conv. Objective	Subj. Ang.	Subj. Conv.	An. of Anom.
Infinity	0	20	20	10	10	10
40 CM.	15	25	40	10	25	15
20 CM.	30	30	60	10	40	20



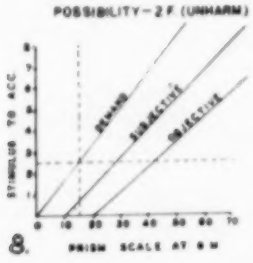


TABLE 8.
Examples of Expected Findings for Possibility—2. The Subjective Angle and Angle of Anomaly Are Covarients and the Objective Angle Varies as the Sum of These Angles. Unharmonious Anomalous Retinal Correspond.

D. Given: A.C.A. = 4
P.D. = 60
Objective Angle = 20 B.O. at Infinity
Subjective Angle = 10 B.O. at Infinity
Angle of Anomaly = 10 B.O. at Infinity

Distance	Conv. Demand	Obj. Ang.	Total Conv. Objective	Subj. Ang.	Subj. Conv.	An. of Anom.
Infinity	0	20	20	10	10	10
40 CM.	15	15	30	7.5	22.5	7.5
20 CM.	30	10	40	5.0	35	5.0

However, if an anomalous fusional movement is present, it could occur in various gradations of intensity or stability, as do the motor fusion skills in individuals with normal binocular vision. For example, if a red lens is placed before one eye of an individual who has previously demonstrated normal fusion, this added obstacle to fusion may break down the fusional response with resultant diplopia, i.e., the eyes assume a phoria position. When the red lens is now removed single vision returns. Again, in normal fusion cases, when peripheral vision is reduced by an instrument, such as a phoropter, on occasion diplopia results which is not otherwise present. The point of speculation then is, if the

TABLE 9.

Examples of Expected Findings for Possibility—2. The Subj. Angle and the Angle of Anomaly Are Covarients and the Obj. Angle Varies as the Sum of These Angles.—Unharmon. Anom. Correspondence.

E. Given: A.C.A. = 6
P.D. = 60
Objective Angle = 20 B.O. at Infinity
Subjective Angle = 10 B.O. at Infinity
Angle of Anomaly = 10 B.O. at Infinity

Distance	Conv. Demand	Obj. Ang.	Total Conv. Objective	Subj. Ang.	Subj. Conv.	An. of Anom.
Infinity	0	20	20	10	10	10
40 CM.	15	20	35	10	25	10
20 CM.	30	20	50	10	40	10

F. Given: A.C.A. = 8
P.D. = 60
Objective Angle = 20 B.O. at Infinity
Subjective Angle = 10 B.O. at Infinity
Angle of Anomaly = 10 B.O. at Infinity

Distance	Conv. Demand	Obj. Ang.	Total Conv. Objective	Subj. Ang.	Subj. Conv.	An. of Anom.
Infinity	0	20	20	10	10	10
40 CM.	15	25	40	12.5	27.5	12.5
20 CM.	30	30	60	15	45	15

TABLE 10.

Examples of Expected Findings for Possibility—3. The Angle of Anomaly Constant With No Anomalous Fusional Movement: Harmonious.

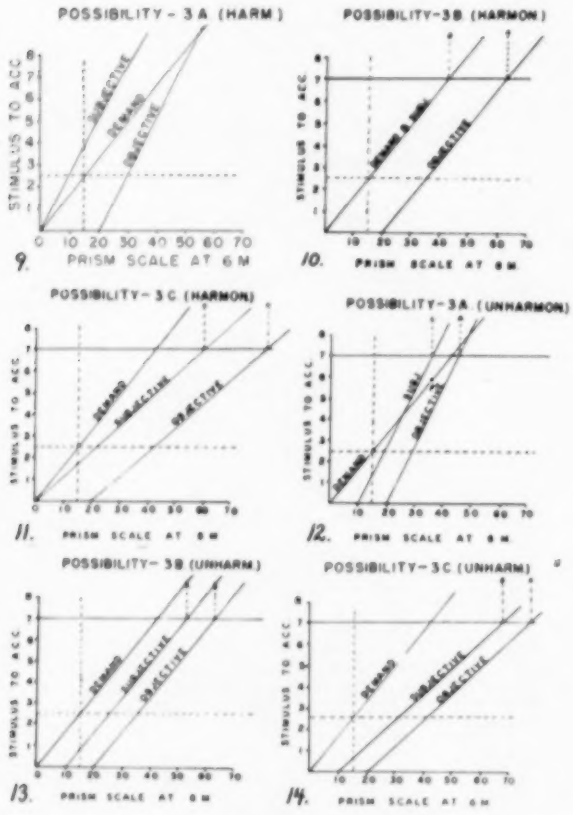
A. Given: A.C.A. = 4
P.D. = 60
Objective Angle = 20 B.O. at Infinity
Subjective Angle = 0 at Infinity
Angle of Anomaly = 20 B.O.

Distance	Conv. Demand	Obj. Ang.	Total Conv. Objective	Subj. Ang.	Subj. Conv.	An. of Anom.
Infinity	0	20	20	0	0	20
40 CM.	15	15	30	— 5	10	20
20 CM.	30	10	40	—10	20	20

B. Given: A.C.A. = 6
P.D. = 60
Objective Angle = 20 B.O. at Infinity
Subjective Angle = O at Infinity
Angle of Anomaly = 20 B.O.

Distance	Conv. Demand	Obj. Ang.	Total Conv. Objective	Subj. Ang.	Subj. Conv.	An. of Anom.
Infinity	0	20	20	0	0	20
40 CM.	15	20	35	0	15	20
20 CM.	30	20	50	0	30	20

anomalous fusional movement is present but not firmly established, it may break down under the testing conditions allowing the eyes to revert to some other position, the measured objective angle. The measured subjective angle would now be of a magnitude other than zero. When the eyes are re-exposed to a normal environment, the movement would



return as does the fusional convergence movement in patients with normal binocular vision. If this does occur, it would mean that the objective and subjective angles as measured may not correspond to those actually present in the normal environment: that the subjective angle in the normal environment is actually zero for all points of fixation and that the objective angle would be altered a like amount. If this anomalous fusional movement is not maintained due to the testing conditions, then the first possibility would simulate the third possibility as mentioned above. This would serve to explain the greater frequency of unharmonious anomalous correspondence found when measurements are taken with optical infinity instruments, with restricted fields of view, than when taken with techniques more nearly duplicating reality.

TABLE 11.

Examples of Expected Findings for Possibility—3. The Angle of Anomaly Constant With No Anomalous Fusional Movement. Harmonious.

C. Given: A.C.A. = 8
P.D. = 60
Objective Angle = 20 B.O. at Infinity
Subjective Angle = 0 at Infinity
Angle of Anomaly = 20 B.O.

Distance	Conv. Demand	Obj. Ang.	Total Conv. Objective	Subj. Ang.	Subj. Conv.	An. of Anom.
Infinity	0	20	20	0	0	20
40 CM.	15	25	40	5	20	20
20 CM.	30	30	60	10	40	20

A. Given: Unharmonious Anom. Correspondence
A.C.A. = 4 P.D. = 60
Objective Angle = 20 B.O. at Infinity
Subjective Angle = 10 B.O. at Infinity
Angle of Anomaly = 10 B.O.

Distance	Conv. Demand	Obj. Ang.	Total Conv. Objective	Subj. Ang.	Subj. Conv.	An. of Anom.
Infinity	0	20	20	10	10	10
40 CM.	15	15	30	5	20	10
20 CM.	30	10	40	0	30	10

TABLE 12.

Examples of Expected Findings for Possibility—3. Unharmonious Anomalous Correspondence.

B. Given: A.C.A. = 6
P.D. = 60
Objective Angle = 20 B.O. at Infinity
Subjective Angle = 10 B.O. at Infinity
Angle of Anomaly = 10 B.O.

Distance	Conv. Demand	Obj. Ang.	Total Conv. Objective	Subj. Ang.	Subj. Conv.	An. of Anom.
Infinity	0	20	20	10	10	10
40 CM.	15	20	35	10	25	10
20 CM.	30	20	50	10	40	10

C. Given A.C.A. = 8
P.D. = 60
Objective Angle = 20 B.O. at Infinity
Subjective Angle = 10 B.O. at Infinity
Angle of Anomaly = 10 B.O.

Distance	Conv. Demand	Obj. Ang.	Total Conv. Objective	Subj. Ang.	Subj. Conv.	An. of Anom.
Infinity	0	20	20	10	10	10
40 CM.	15	25	40	15	30	10
20 CM.	30	30	60	20	50	10

In relation to the above discussion, the authors have observed that in eliminating harmonious anomalous correspondence, the condition may change to unharmonious anomalous correspondence before manifesting normal correspondence. Characteristically, the repeated troposcope measurements show a gradual increase in the magnitude of the sub-

jective angle and a gradual but much smaller decrease in the objective angle until the two finally equal each other.

The size of the angle of anomaly and the A.C.A. ratio would be a factor here. Some authorities believe the angle of anomaly is formed at a specific distance of fixation and thereafter is maintained for all other distances. If this is correct the angle of anomaly would have a magnitude commensurate with the distance at which it started.

A recent study on "fusional phenomena" in anomalous correspondence was conducted by Halliden.[6] He investigated the variation of the angle of anomaly and of the objective and subjective angles as a function of time. Although his sample was small, the results tended to show a covariation of the objective angle and the angle of anomaly in non-operated strabismics (five cases) all of whom demonstrated harmonious anomalous correspondence. This reaction would appear of the same type as that mentioned in that portion of possibility #2 regarding harmonious anomalous correspondence. The operated strabismics (four cases) all demonstrated unharmonious anomalous correspondence and did not show a conclusive covariation. He also investigated this aspect by placing prisms of different power and direction before the eyes. The results were variable but the majority showed no change in the angle of anomaly with the objective and subjective angle changing an amount approximating the prism power. This reaction parallels possibility #3.

If possibility #2 occurs, the accommodative convergence changes would be manifest and measurements of the A.C.A. ratio could be obtained by measuring the objective angle at different distances of fixation. However, if a harmonious relationship is maintained, the subjective angle would remain zero and therefore could not be used as an indication of the A.C.A. ratio. It implies that the magnitude of the angle of anomaly would be constantly changing with variation in fixation distance, unless an A.C.A. ratio of six exists. This possibility would again appear to be a logical adaptive reaction in harmonious anomalous correspondence but would appear completely illogical and useless in unharmonious anomalous correspondence. That is to say, a harmonious case through this process could remain harmonious at all distances and an unharmonious case could remain unharmonious. If this variation in the angle of anomaly actually occurs it would mean that a different pattern of directionalization must be present for each change in fixation distance where the A.C.A. ratio is other than six. Also if this possibility occurs in harmonious anomalous correspondence with an A.C.A. ratio of less than six, and the distance of fixation is

reduced to the crossing point of the visual axes, then at this point, the angle of anomaly would be zero and the condition would now be that of normal correspondence.

If possibility #3 exists, a number of reactions are possible depending upon, (1) the infinity condition, that is, harmonious or unharmonious anomalous correspondence; (2) the magnitude of the angle of anomaly at infinity and (3) the A.C.A. ratio. This is true in this instance as no anomalous fusional movement would be present and the subjective and objective angles would both vary directly with the A.C.A. ratio. Thus measurements of either the subjective or objective angle at different distances of fixation would give a true indication of the A.C.A. ratio. If an A.C.A. ratio of less than six exists and the condition is harmonious at the infinity position, it would not remain harmonious for any distance within infinity. (See Figure 9 and Table 10.) If on the other hand an A.C.A. ratio of less than six exists and the condition is unharmonious at the infinity position, it would become harmonious at some finite point. (See Figure 12 and Table 11.)

If the A.C.A. ratio is six and the condition is harmonious at infinity, the same relationship would exist for all distances until the amplitude of accommodation is reached. At any closer distance the condition would no longer be harmonious. (See Figure 10 and Table 10.) The same would apply to an unharmonious case with an A.C.A. ratio of six, except that after the amplitude of accommodation is reached the condition at some closer distance would become harmonious. (See Figure 13 and Table 12.)

If now an A.C.A. ratio of greater than six be considered with a harmonious relationship at infinity, the condition would become unharmonious and remain so for any finite distance until the amplitude of accommodation is reached. At some point closer than the amplitude it would revert back to harmonious. (See Figure 11 and Table 11.) In the case of an unharmonious condition at infinity with an A.C.A. ratio greater than six, the condition would remain unharmonious until the accommodative amplitude is reached and for some distance thereafter. If the distance is decreased sufficiently, the condition would become harmonious. (See Figure 14 and Table 12.)

The various reactions described for possibilities #1, #2, and #3 are presented in graphical form, together with tables demonstrating the specific findings which would be expected at three testing distances. In each case a specific amount of data has been assumed to be present at infinity and all examples are for esotropes.

PROPOSED EXPERIMENTAL PROCEDURE

In order to obtain sufficient information regarding the existence or non-existence of the discussed possibilities, the objective angle, subjective angle, angle of anomaly and gradient measurements will have to be accurately determined at a sequence of specific testing distances. An overhead haploscope* with a stigmatoscope attachment to measure accommodative responses will be employed. Half silvered mirrors will be used to permit observation of projected targets at the testing distance as well as haploscopic targets.

The testing technique for the measurement of the objective angle and angle of anomaly is patterned after the Halldén technique[6] in the use of the afterimage. However, the overhead haploscope will permit direct measurements of the angles, thereby eliminating the necessity for their calculation from the screen.

The objective angle will be measured as follows: a circular afterimage will be created in the deviating or non-fixating eye. With the patient properly positioned under the haploscope, the fixating eye will fixate a projected form target of a size demanding visual acuity commensurate with the patient's maximum ability. With no room illumination and an excluding filter before the non-fixating eye, to prevent the projected target from being visible to this eye, a haploscopic target consisting of a circle of light will be reflected into the non-fixating eye. The subject will be instructed to advise the examiner when the direction of this circular light coincides with the center of the afterimage. The angle through which the circle of light must be moved to obtain this response will be a direct measure of the objective angle. The same procedure will then be repeated with the excluding filter removed and with normal room illumination.

An alternate method for measuring the objective angle which may be employed (if the afterimage technique is unsuccessful) involves the projection of two form targets onto a screen by means of twin projectors.† The fixation will be altered from the one target to the other by means of alternate occlusion and the separation of the targets will be altered, both horizontally and vertically, until all eye movement has stopped. Scales on the projectors will again give the measure of the objective angle.

The subjective angle will be measured as follows: A target of a size requiring the best visual acuity present will be projected onto a screen and fixated by the fixating eye. A haploscopic target consisting

*Designed by Henry Knoll and Henry Hofstetter.
†Patterned after those designed by Merton Flom.

of a circle of light will be reflected into the non-fixating eye. With no room illumination and an excluding filter before the deviating eye the subject will be instructed to inform the examiner when the haploscopic target appears to lie in the same direction as the projected target. The angle through which the haploscopic target must be moved to obtain this response will be a direct measurement of the subjective angle.

The procedure will then be repeated with normal room illumination, with a polarized form target projected onto the screen, visible to only the fixating eye, with no excluding filter before the non-fixating eye, and with the same haploscopic target. A third method will be the same as above with the exception that the projected target will not be polarized, i.e., it will be visible to both eyes.

An alternate method for measuring the subjective angle will be the projection onto a screen of two polarized targets by twin projectors, one target visible to each eye. One target will be a form target demanding the best visual acuity present and the other will be a circle. The circle will be moved until it appears to surround the other target. Scales on the projectors will give the measurement of the angle.

The angle of anomaly will be determined as follows: A circular afterimage will be created in the non-fixating eye. With the patient properly seated under the haploscope, a target requiring the best visual acuity present will be projected onto a screen and will serve as the fixation point for the fixating eye. A haploscopic target consisting of a circle of light will be reflected into the fixating eye and moved until the subject reports it lying in the same direction as the center of the afterimage. The angle through which the haploscopic target must be moved will give a direct measurement of the angle of anomaly.

An alternate method which may be employed again involves the use of twin projectors. With the circular afterimage created in the non-fixating eye a form target requiring the best visual acuity present will be projected onto a screen and will serve as the fixation point for the fixating eye. Another circular target, polarized and visible only to the fixating eye will be projected onto the screen. This latter target will be moved until it appears to be in the center of the afterimage. The scale on the projectors will give the dimension of the angle of anomaly.

The stigmatoscope will be used simultaneously with the measurements of the subjective and objective angles to determine the accommodative response present at each testing distance. The gradients will be determined at each distance after the objective and subjective angles have been measured. They will be obtained both under conditions of no room illumination and normal room illumination. The accom-

modative demands presented include a zero demand at each testing distance. The testing distances will be 6 meters, 40 cms., and 20 cms. It is planned to test subjects with both normal and anomalous correspondence. Variations in the testing procedure may be made if the need arises.

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ANNOUNCEMENT

CONFERENCE ON UTILIZATION OF RECORDED KNOWLEDGE

A conference on the Practical Utilization of Recorded Knowledge will be offered by the School of Library Science and its Center for Documentation and Communication Research of Western Reserve University, Cleveland, Ohio, January 16-18, 1956.

The purposes and objectives of the conference are: (1) To identify areas of possible cooperation and promote mutual understanding between users and processers of information. (2) To outline possible cooperative programs for organization and distribution of information, with particular attention to abstracting, indexing, analysis for machine searching, and exchange of information in organized form. (3) To define the underlying principles of information analysis and correlation. (4) To devise a curriculum pattern which will prepare information specialists to exploit most effectively those resources which the future will make available.

The registration fee is $10. Checks should be made payable to Western Reserve University and sent to Dean Jesse H. Shera, School of Library Science, Western Reserve University, Cleveland 6, Ohio.

LABORATORY ANALYSIS OF A GROUP SCREENING TEST FOR VISUAL ACUITY*

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INTRODUCTION

Vision screening tests have been widely used for several years in various surveys in industry, for driver's licensing and in schools. Lauer,[5] Silver[11] and others, using standard optometric measures collected large numbers of measurements on automobile drivers which were reported in some detail at the 39th Optometric Congress in Detroit in 1937. Hitz[3] has observed that the regular ophthalmic examinations used in the office of practitioners are impractical for screening purposes. In several studies made at Iowa State College and reported in various papers,[5, 6, 7] it was found that in the more enlightened communities many more persons receive proper eye-care than in the backward communities. It is estimated that only one-fourth of the non-clinical population wear glasses regularly, about half wear them a part of the time, another twenty-five per cent definitely have visual problems, while only about ten per cent have little or no eye trouble. This would indicate that nearly half of those who should consult vision specialists of all types rarely, if ever, have a *bona fide* visual examination.

Thus the widespread use of a satisfactory screening test for vision should accomplish at least the following three objectives:

1. It would tend to make the public more eye conscious.
2. It would pick up many cases of eye trouble not ordinarily discovered.
3. It would increase the number of persons seeking visual care, training and correction.

This has been the experience in nearly every community where eye clinics for screening purpose have been held. It has proved not only beneficial to public health but has enhanced public relations when properly conducted.

Screen tests are defined here as any application of charts, pencil-

*Read before the annual meeting of the American Academy of Optometry, Chicago, Illinois, December 5, 1953. This study was aided in part by a Research Fellowship grant from the Allstate Insurance Company. It is the first phase of a study being carried out to develop a pencil-and-paper test for driving vision. For publication in the December, 1955, issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.

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and-paper forms, devices or instruments designed for measuring or detecting certain anomalies of vision quickly and with slide-rule accuracy. It is short of a complete optometric examination or equivalent with ophthalmic precision methods. Screen tests are administered by trained personnel who may or may not be registered vision specialists. An example would be the driver's license examiners in most states who are permitted by law to make screening tests of drivers.

Only three instruments of precision nature, incorporating both near-point and far-point vision, are widely used for vision screening purposes and neither of these devices measures astigmatism, nor can they be used to measure vision in groups. An individual screening test, even a short one, is not feasible to use in many situations. Group tests of hearing have been used for several years in the schools although the apparatus is inconvenient to administer to any number of persons and subject to damage if used often.

Some attention has already been given to the use of group pencil-and-paper tests of vision. The ultimate problem to be considered is largely that of securing a device or instrument which will give a fair index of both near-point and far-point acuity for several persons at one time.

Steinberg,[11] however, points out that the measurement of acuity, especially at the near-point, is the essential core of most vision-testing in industry at the present time. This is also true of the schools where some efficient system for periodic checking of vision is needed. Anyone versed in vision measurement and efficiency and who is teaching at the college level is aware of the inefficiency of present practices of screening out or otherwise detecting faulty vision of students in the public and private schools.

It has seemed desirable to explore the possibilities of using a pencil-and-paper approach to the screening test of vision, even with many inherent limitations which are recognized.

Certain variations on the Snellen Test and other standard measures of vision for use with groups have been introduced by Berens,[1] Eames,[2] Imus[4] and others. Moore[10] used specially designed cards to detect possible malingerers on vision tests of Army personnel. Kirschner[9] employed a method for measuring far-point vision in groups that is somewhat similar to the present approach. The present paper is confined to a study of near-point testing only.

STATEMENT OF THE PROBLEM

The present study involved the utilization of certain pencil-and-paper tests of visual acuity which had been administered to large

groups and the results of which had been correlated with Snellen chart, Sight Screener and Ortho-Rater scores. When corrected for attenuation, variance due to unreliability of instruments and the Snellen chart, the correlations were found to be of the order of .10 to .30. Although significant at the five per cent level of confidence the coefficients were not sufficiently high for individual prediction. Although several reasons may be given for these low correlation coefficients, the most obvious seemed to be that the subjects had already been doubly screened and constituted a relatively homogeneous group with respect to visual acuity since few had vision below 20/20. Correlations between two types of standard vision screening instruments at the far-point and the Snellen chart measurements yielded coefficients of .54 and .67 respectively. A much longer procedure was used for the second instrument which probably accounts for the higher degree of correlation. Thus it appears that Snellen measurements as such do not show a perfect validity when correlated with screening devices which have been found to have quite high reliability.

HYPOTHESIS

From a study of the previous work in the field, the hypotheses for the present study were formulated as given. The main hypothesis for this investigation may be stated as follows:

The Visual Acuity Test is a valid and reliable instrument for screening of near-point binocular acuity when administered under specified conditions of distance and illumination.

In order to determine the consistency of measurement and validity of the test being evaluated under operational conditions, laboratory controls approximating the practical variations in light and distance likely to be found in group testing situations were introduced experimentally. Two levels of light intensity on the test and two distances from the eye were used. These were arbitrarily set at four and sixteen foot candles of light and at ten and eighteen inch distances based on actual measurements and field observations.

It is assumed that light levels above those used in this study would not constitute a problem, being reasonably satisfactory, and that no distance not between the two stipulated limits would ordinarily be encountered in a pencil-and-paper situation.

DESIGN OF THE STUDY

It should be emphasized that the study is an individual approach to the group testing problem and was carried out under controlled laboratory conditions. A group-test of 125 items consisting of five subtests was administered individually to four groups of 25 college students in

Plate 1.

each group, or 100 in all. Statistical evaluations were applied to the data. These included calculations of reliability coefficients and were made with the criterion under the four experimental conditions used.

The criterion throughout was the Ortho-Rater score using standard procedures as outlined in the manual and the regular Ortho-Rater charts. The binocular score was used as one criterion, and a composite score consisting of the binocular score plus measurement made of each eye separately was used as the other.

EXPERIMENTAL DESIGN

The following experimental conditions were introduced in the administration of the Visual Acuity Test:

Condition 1. Distance from eye to target, ten inches; illumination, four foot candles.

Condition 2. Distance from eye to target, ten inches; illumination, sixteen foot candles.

Condition 3. Distance from eye to target, eighteen inches; illumination, four foot candles.

Condition 4. Distance from eye to target, eighteen inches; illumination, sixteen foot candles.

Independent groups of 25 subjects were randomly chosen for each of these conditions.

The reliability of the subtests of the visual acuity test, as well as

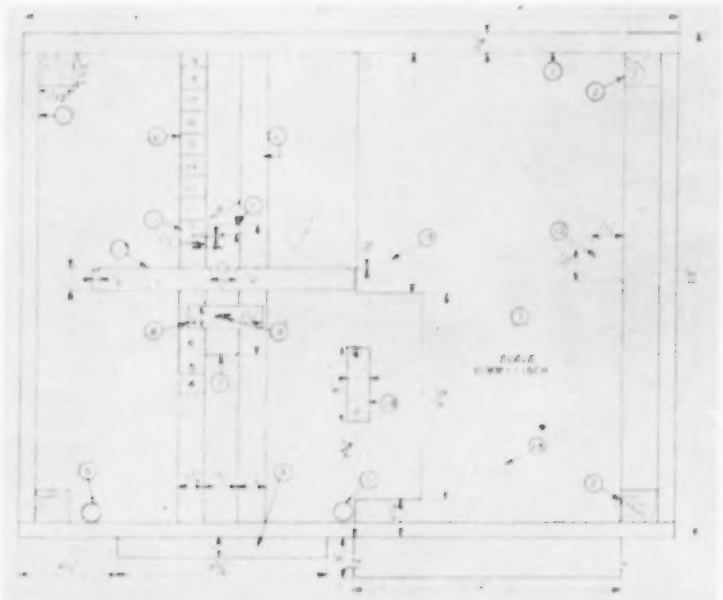

FIGURE 1 - EXPERIMENTAL BOX- TOP VIEW

the reliability of the total score under each experimental condition was determined by the odd-even method using the Spearman-Brown correction formula. Both the means and variances of the halves of the test were assumed to be equal.

Product-moment correlations were obtained between each of the subtests and the two criteria for each condition. The validities of the entire visual acuity test for each condition were estimated by means of multiple correlations. Only those subtests that had individual validity coefficients which were significant at the five per cent level of confidence or better were used as predictors in these multiples.

To determine if prediction were better under some conditions than others, Fisher's z transformation was made on the multiple correlation coefficients and a chi-square analysis, as suggested by Snedecor[12] and adapted by Kempthorne,[8] was applied to test for homogeneity of correlation among the different experimental conditions.

APPARATUS

The apparatus used in this study consisted of a standard Bausch and Lomb Ortho-Rater and an experimental box for presenting the visual acuity test targets (Plate 1, Figures 1, 2 and 3). Figures 1, 2 and 3 show the construction of the

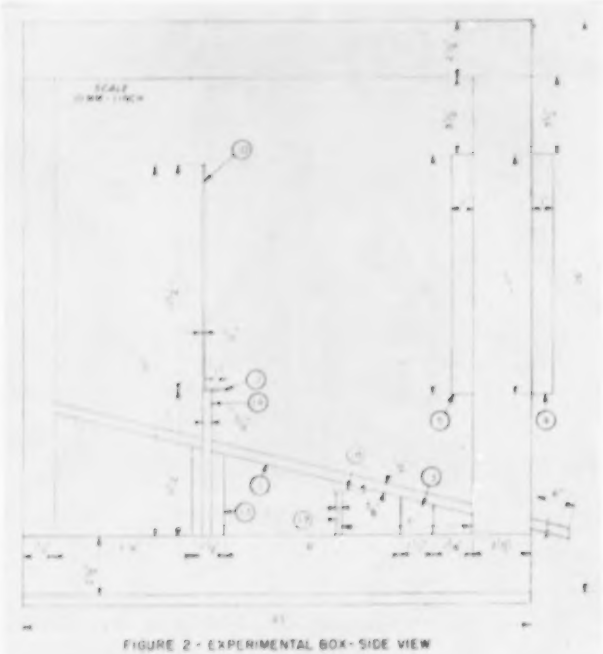

FIGURE 2 - EXPERIMENTAL BOX - SIDE VIEW

experimental box; numbers always refer to the same part; thus number 3 always refers to the table while number 5 always refers to the lights.

The box had a frame work of wood 23 inches long, 30 inches wide, and 26 inches high. The out frame (1) consisted of 2½ x ¾-inch wood and 1½-inch plywood and supported by three 1½-inch square blocks was placed on the right hand side of the box for use as an arm rest. This table extended six inches beyond the front of the box so that the subject's entire forearm could be rested upon it.

The viewing mask (4), a baseball catcher's mask from which the wire screening had been removed, was clamped to a ½-inch plywood panel (15) in which a hole the exact size of the mask had been cut. This assembly was mounted on tongued blocks and installed in the front of the box between grooved strips (16). In this way it was possible to raise or lower the viewing mask to allow for different sitting heights of the subjects. The distance of the eye from the target was the same for all subjects.

The grooved strips (6) and a grooved block (7) were installed in the floor of the box directly in front of the viewing mask. A stand (10) to hold the test booklet was anchored in the tongued block. A bolt was set in this block and extended through a hole in a metal bar (8). By tightening the wing nut (9) the block could be forced up against the supports and the whole assembly held securely at any point along the full length of these strips. A metal pointer (11) was attached to the block and the grooved strips were calibrated in such a way as to indicate the distance from the viewing mask to the test booklet holder. Thus, when the pointer was set at the number 10 on the strip, the distance from the test booklet to the eyes of the subject was 10 inches.

The test booklet holder was attached to a telescoping metal stand (14) so that it could be adjusted up or down when the viewing mask was moved. The

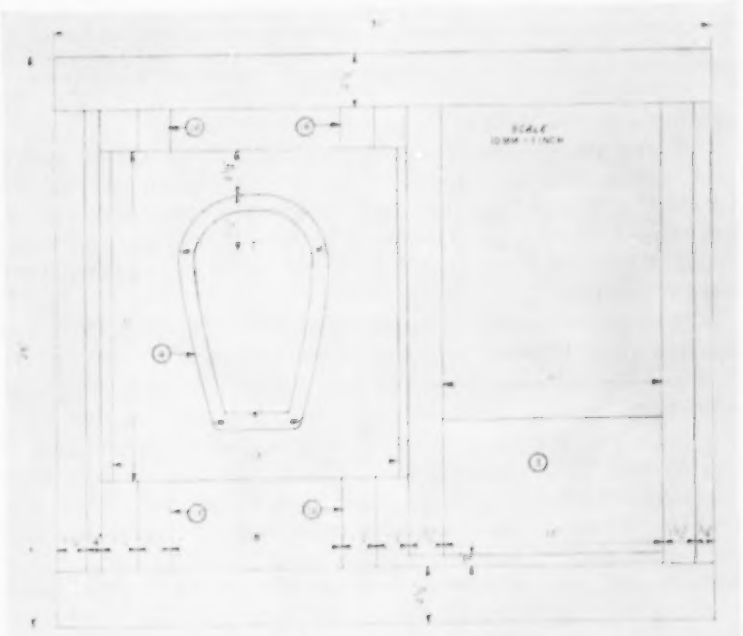

FIGURE 3 - EXPERIMENTAL BOX - FRONT VIEW

bottom of the test holder was always aligned with the bottom of the viewing mask no matter how high or low it was necessary to move the latter in order to fit a given subject.

Two 11-inch Lumaline lamps (5) were mounted vertically on the opposite side of the plywood panel which held the viewing mask. These were located on each side of the mask and were placed far enough back to prevent them from being seen by the subject or to produce effective glare. A Variac (rheostat) was used on the power circuit to control the voltage to the lamps. The level of illumination on the test booklet was calibrated by means of a Weston photo-electric cell with Viscor filter, and measuring the output by a d'Arsonval galvanometer. The cell had been previously calibrated by a MacBeth Illuminometer. The rheostat was then adjusted until levels of four and sixteen foot candles were reached at the two distances of ten and eighteen inches. Several different readings were taken at various positions on the test holder and, since these did not vary appreciably, the distribution of light intensity on the test booklet was assumed to be sufficiently uniform. The line voltage was known to be relatively constant and any changes in color characteristics of the different levels of light resulting from the rheostat were assumed to be negligible.

To simulate the experience of looking down at the test booklet, as would be the case in actual group testing, it was necessary to provide a means for tilting the entire experimental box. This was accomplished by installing a large adjusting screw (15) along the center line of the floor of the cabinet and extending the screw through the floor to a table on which the apparatus rested. The back was secured by two large hinges and as the screw was adjusted only the front end of the box moved up or down. By adjusting the front end vertically any degree of tilt could be given to the apparatus.

The viewing box was painted a dull black and covered with two layers of heavy black sateen cloth. The only openings in this cloth were the aperture in the viewing mask and an opening cut to admit the subject's right hand and arm. The latter opening was provided with a flap of material to prevent light from entering the box at this point.

METHOD AND PROCEDURE

Eighty-five men and 15 women were used as subjects in the experiment. They were recruited from reading improvement, psychology, and other classes. The subjects were randomly assigned to one of the four experimental groups. To increase the heterogeneity of visual acuity among individuals of the groups, those with correction were examined without glasses.

Each subject was read standard instructions. The Ortho-Rater test was then given, followed by the pencil-and-paper test using one of the experimental conditions in the 2x2 design which he had been assigned as described.

Space will not permit detailed description of the targets used in each subtest. One resembled the McCallie dot-in-circle test, some employed the Ortho-Rater targets with variations, certain ones were constructed of letters of graduated sizes, while others were adaptations of the Vernier test of vision and Landolt rings. The size and degree of difficulty had been established by using the particular visual angle which provided the proper threshold limits of discrimination at a normal near-point reading distance.

The subject marked his answers on a five-answer form of IBM multiple-choice sheet and conventional methods of scoring were used. The data were then punched on IBM cards for further convenience in statistical treatment.

RESULTS

Consistency of measurements from the various pencil-and-paper subtests are shown in Table 1 for each of the four groups of subjects

Certain assumptions were made with respect to the means and variance of chance halves of the tests, possible differences in the age and acuity of the groups, and the test conditions. Results from analysis of variance are shown in Tables 2 and 3.

The intercorrelations of tests, criteria and subtests are shown for each experimental group in Tables 4, 5, 6 and 7, respectively.

By using subtests with validities significant at the five per cent level or better, multiple R's were computed for each experimental condition as shown in Table 8.

Only Subtest IV showed significant performance in all four experi-

TABLE 1.
Odd-Even Correlations and Spearman-Brown Corrected Reliabilities for Visual Acuity Test Scores.

Group	Subtest I r	Subtest I Corrected r	Subtest II r	Subtest II Corrected r
1	.8856	.9393	.8103	.8952
2	.9485	.9736	.2148	.3536
3	.9758	.9878	.9287	.9630
4	.9679	.9837	.9287	.9630
	Subtest III		Subtest IV	
1	.7788	.8756	.9749	.9873
2	.8761	.9340	.6715	.8035
3	.9213	.9590	.8665	.9285
4	.8623	.9261	.9057	.9505
	Subtest V		Total Score	
1	.3861	.5571	.9623	.9808
2	.2288	.3724	.9620	.9806
3	.1791	.3038	.9699	.9847
4	.5079	.6737	.9632	.9813

TABLE 2.
Analysis of Variance for Age.

Source of Variation	d.f.	S.S.	M.S.	F
Groups	3	46.44	15.4800	.8705
Error	96	1,707.12	17.7825	
Total	99	1,753.56		

TABLE 3.
Analysis of Variance for Binocular Near-Point Acuity.

Source of Variation	d.f.	S.S.	M.S.	F
Groups	3	6.35	2.1167	.3892
Error	96	522.16	5.4392	
Total	99	529.51		

mental conditions. This is probably due to the varied nature of the targets.

The chi-square test for homogeneity of correlations was applied and no significant differences were found between the R's of the four experimental groups. Consequently it seemed feasible to pool the scores from the different groups for purposes of obtaining validities on each subtest for the whole group of 100 subjects. These results are shown in Table 9.

Comparison of column one with column two in Table 9 indicates that the "total score" on the criterion can be predicted somewhat better than the "binocular score." This would be expected since the test was lengthened and certain effects of monocular seeing included. All validities, however, were above the one per cent level of confidence.

TABLE 4.
Group 1—Validities and Intercorrelations of Visual Acuity, Test and Subtests.

No.	Variable	Variable Number 1	2	3	4	5	6	7	8
1.	Ortho-Rater Binocular	____	____	____	____	____	____	____	____
2.	Ortho-Rater Total	.835**	____	____	____	____	____	____	____
3.	Subtest I Total Score	.417*	.472*	____	____	____	____	____	____
4.	Subtest I R-W Score	.376	.436*	.097	____	____	____	____	____
5.	Subtest II Total Score	.505**	.555**	.127	.426	____	____	____	____
6.	Subtest III Total Score	.185	.211	—.125	.323	.594	____	____	____
7.	Subtest IV Total Score	.556*	.598*	.172	.405	.548	.572	____	____
8.	Subtest V Total Score	.523**	.608**	.122	.364	.591	.531	.597	____
9.	Total Score	.452*	.503**	.369	.282	.496	.398	.556	.465

*Significant at .05 level of confidence.
**Significant at .01 level of confidence.

TABLE 5.
Group 2—Validities and Intercorrelations of Visual Acuity, Tests and Subtests.

No.	Variable	Variable Number 1	2	3	4	5	6	7	8
1.	Ortho-Rater Binocular	____	____	____	____	____	____	____	____
2.	Ortho-Rater Total	.662**	____	____	____	____	____	____	____
3.	Subtest I Total Score	—.019	.006	____	____	____	____	____	____
4.	Subtest I R-W Score	.202	.413*	.132	____	____	____	____	____
5.	Subtest II Total Score	.124	.156	.146	.069	____	____	____	____
6.	Subtest III Total Score	.047	.094	.083	—.258	.034	____	____	____
7.	Subtest IV Total Score	.506**	.695**	—.141	.254	.063	.241	____	____
8.	Subtest V Total Score	.326	.512**	—.140	.088	.003	.284	.481	____
9.	Total Score	.410*	.600**	.232	.181	.229	.646	.613	.413

*Significant at .05 level of confidence.
**Significant at .01 level of confidence.

It seems feasible, by further study, to devise types of tests which will not only function between the limits of light and distance imposed in this study but at greater ranges of variation. Continued research is

TABLE 6.
Group 3—Validities and Intercorrelations of Visual Acuity Test and Subtests.

No.	Variable	Variable Number 1	2	3	4	5	6	7	8
1.	Ortho-Rater Binocular	____	____	____	____	____	____	____	____
2.	Ortho-Rater Total	.718**	____	____	____	____	____	____	____
3.	Subtest I Total Score	.528**	.673**	____	____	____	____	____	____
4.	Subtest I R-W Score	.193	.243	.111	____	____	____	____	____
5.	Subtest II Total Score	.642**	.745**	.725	.308	____	____	____	____
6.	Subtest III Total Score	.486*	.601**	.507	.220	.664	____	____	____
7.	Subtest IV Total Score	.604**	.745**	.621	.333	.772	.630	____	____
8.	Subtest V Total Score	.387*	.506**	.478	.292	.698	.650	.622	____
9.	Total Score	.564**	.697**	.762	.213	.794	.650	.725	.599

*Significant at .05 level of confidence.
**Significant at .01 level of confidence.

TABLE 7.
Group 4—Validities and Intercorrelations of Visual Acuity Test and Subtests.

No.	Variable	Variable Number 1	2	3	4	5	6	7	8
1.	Ortho-Rater Binocular	____	____	____	____	____	____	____	____
2.	Ortho-Rater Total	.825**	____	____	____	____	____	____	____
3.	Subtest I Total Score	.508**	.656**	____	____	____	____	____	____
4.	Subtest I R-W Score	.434*	.478*	.192	____	____	____	____	____
5.	Subtest II Total Score	.675**	.783**	.683	.402	____	____	____	____
6.	Subtest III Total Score	.415*	.600**	.608	.328	.800	____	____	____
7.	Subtest IV Total Score	.551**	.630**	.565	.447	.767	.674	____	____
8.	Subtest V Total Score	.618**	.740**	.588	.454	.738	.642	.660	____
9.	Total Score	.566**	.683**	.824	.319	.792	.705	.741	.677

*Significant at .05 level of confidence.
**Significant at .01 level of confidence.

being made on the adaptation of the test to far-point vision for use in drivers' licensing or other applications of group screening tests for vision involving far-point vision. The present study is limited to conditions of near-point vision.

TABLE 8.
Multiple Correlations Between Visual Acuity Test Scores and Two Criteria of Near-Point Acuity.

Group	Subtests Used as Predicators	Criterion	R.*
1.	I, II, III, IV and V	Ortho-Rater Binocular Score	.7002
2.	IV	Ortho-Rater Binocular Score	.5058
3.	I, II, III, IV and V	Ortho-Rater Binocular Score	.6811
4.	I, II, III, IV and V	Ortho-Rater Binocular Score	.7402
1.	I, II, III, IV and V	Ortho-Rater Total Score	.7828
2.	I, (R-W), IV and V	Ortho-Rater Total Score	.7669
3.	I, II, III, IV and V	Ortho-Rater Total Score	.8149
4.	I, II, III, IV and V	Ortho-Rater Total Score	.8337

*All values are significant at the .01 level of confidence.

TABLE 9.
Validities of Visual Acuity Test After Data from All Conditions Were Pooled.

Predictor	r with Ortho-Rater Binocular Score	r with Ortho-Rater Total Score
Subtest I Total Score	.3926	.5230
Subtest I R-W Score	.2881	.3561
Subtest II Total Score	.4683	.5591
Subtest III Total Score	.3115	.4140
Subtest IV Total Score	.5200	.6141
Subtest V Total Score	.3992	.4970
Total Score	.4647	.5814

Legend: All values are significant at the .01 level of confidence. N = 100.

SUMMARY AND CONCLUSIONS

A laboratory analysis was made of a pencil-and-paper group screening test of visual acuity. One hundred college students were randomly divided into four groups of 25 subjects and each of the groups was subjected to one of four experimental conditions using a 2x2 design. The four conditions were paired combinations of ten inches and sixteen inches distance, with four and sixteen foot candles of illumination respectively. Statistical evaluations of reliability and validity of the test and subtests were made for each of these conditions.

Within the framework and general scope of the study, limitations imposed by the number and nature of subjects used and other factors involved the following tentative conclusions may be drawn:

1. The hypothesis as stated that the pencil-and-paper group

visual acuity screening test used in this study is reliable and valid is affirmed.

2. Reliabilities and validities are sufficiently high for application of such a pencil-and-paper screening test of near-point vision to conditions between the limits of those studied in this investigation.

3. Further work needs be done before such test may be offered for general usage and particularly for use in measuring far-point vision.

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ANNOUNCEMENT

FORUM ON VISUAL PROBLEMS IN SCHOOLS

The American Optometric Association has announced that the annual A.O.A. Forum on Visual Problems in Schools will be held in Cleveland, Ohio, February 24-26. Following the Forum meeting a Strabismic Institute under the direction of Dr. T. R. Murroughs will be held, February 27 through March 2.

Advance reservations may now be made for the Institute through Dr. Lois B. Bing, 2775 South Moreland Blvd., Cleveland 20, Ohio. The registration fee is $100.

MEASURING BIFOCAL ADDITIONS*

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In the old days, the addition which a patient required for near work was easily determined: leaving his distance prescription in the trial frame one placed additional lenses in front of it to enable the patient to get a clear image of the reading matter. The optical basis of this procedure is very sound. The distance prescription brings a clear image of an infinitely distant object in the far point of the patient's eye and the near addition acts in the nature of a collimating lens, making, in effect, the bundle of rays coming from a near object parallel before letting them through the distance portion which in turn focuses them in the far point of the patient's eye.

This is precisely what we want to happen: in the case of the absolute presbyope we want rays coming from infinity to be focused by the distance portion of the bifocal in the far point of the eye, and rays coming from the near object distance to be brought to a focus in the same point through the near portion of the bifocal lens (Figure 1).

Let us first examine the specification of the lens in the refractor or phoroptor which enables this result to be achieved. Refractors usually specify lenses in terms of back vertex powers.

Suppose we have a 5 D. hyperope without accommodation who is to read at 1/3 meter. For a target at infinity, the refractor will indicate +5 D., signifying correctly that the patient's far point is situated exactly 0.20 meters behind the back vertex of the lens in the instrument. Does this mean that a +8.00 D. combination of lenses in the instrument will bring rays from an object at 1/3 meter in front of the spectacle plane to a focus in the far point of the patient's eye? The answer is: not necessarily. The +8.0 D. merely signifies that parallel rays will be brought to a focus at a distance of 1/8 meter = 12.5 cm. behind the back vertex of the lens. The position of the image of an object at 1/3 meter produced by this lens will depend on the position of the principal points, since the usual object/image relationship $L' = F + L$ can only be used when the object and image distances are measured from the principal points.

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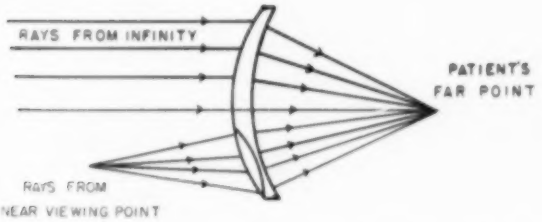

Fig. 1. Function of a bifocal lens for an absolute presbyope. The distance portion focuses parallel rays in the far point, and the near portion images the near viewing point in the far point.

If the principal points of the lenses in the refractor are situated fairly close to the back vertex, no problem will arise and the usual lens formula applies. For example, the +8.00 D. lens will serve equally to focus rays from infinity at 1/8 meter and to image an object at 1/3 meter in the far point of 5 D. hyperope's eye.

As an example, let us consider the case in which the lenses in a hypothetical instrument have their principal points close together but situated 1 cm. in front of the back vertex of the lens. In this case, an object 0.333 meters in front of the spectacle plane will have an object distance of 0.332 meters with respect to the principal plane. This makes the required image distance 0.21 meters and substituting in the thin lens formula we find that the lens required to focus rays from the designated near point in the far point of the patient's eye has a principal point power of +7.86 D. and, since the principal points are situated 1 cm. in front of the back vertex of the lens, the latter will have to have a back vertex power of +8.55 D. In other words, a lens with a +8.00 D. back vertex power will not do the anticipated job in this case.

The effect, of course, is only of noticeable magnitude in instances in which the addition is strong and particularly when the distance prescription is reasonably powerful. Obviously, designating testing lenses by vertex powers alone does not tell the whole story.

Precisely the same reasoning is applicable in the measurement of completed bifocal lenses.

Suppose a lens is designed to bring rays from infinity to a focus in the patient's far point, i.e., 20 cm. behind the back vertex of the lens in our example, through the distance portion, and from a point 1/3 meter in front of this spectacle point to an image also in this far point through the near portion of the lens.

Unless the principal points are close to the back vertex of the lens, the back vertex power of the near portion will not be equal to +8.00 D.

The exact value will depend on the constants of the lens and will have to be evaluated.*

The optical construction of many types of bifocals happens to place the added near vision component fairly close to the *front vertex* of the lens and this makes the difference in the front vertex or neutralizing power between the distance and the near portions a fairly good indicator of the difference between the effective object distances of the two parts for a given fixed image distance. This is, in fact, the method of measuring bifocal additions advocated by some optical manufacturers.

There seems to be at least one method of measuring bifocal additions which overcomes all these difficulties. It is based on simulating the actual conditions under which the bifocal wearer will be operating with his lenses. Through the distance portion we want him to have objects at infinity focused in his far point, and this is actually what happens when, in measuring the power of the distance portion by means of the vertometer, we have adjusted the position of the vertometer target so that a clear image of it is seen in the ocular (Figure 2).

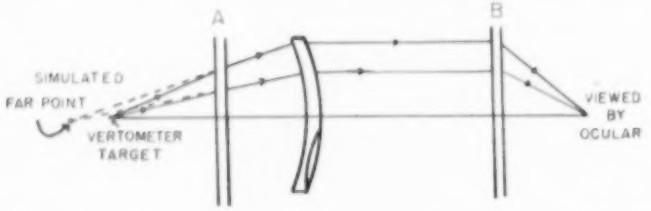

Fig. 2. Operation of the vertometer in measuring the back vertex power of the distance portion of a bifocal lens. The vertometer target is moved so that when it is imaged by lens A, the rays become parallel as they emerge from the spectacle lens. The parallelism is tested by viewing the focus of these rays, as formed by lens B, by means of an ocular. Note that direction of the rays is reversed compared with that in Fig. 1, but that the image of the vertometer target formed by lens A is comparable to the far point of the eye since it is conjugate to infinity with respect to the distance portion of the bifocal lens.

Through the near portion we want objects from the designated near viewing point to be imaged in his far point. This is illustrated in Figure 3. The rays through the reading portion, when they are collected by the lens B of the vertometer will come to a focus in a point

*A special analysis would be required in the case in which the patient is expected to use some accommodation. In this case the requirement for the near portion is to image the designated near point in a point which has become conjugate with the retina with the eye in the accommodated state. Since this usually means having a low power addition detailed studies of such cases seem hardly warranted. Such factors as depth of focus also enter the discussion but will not be treated here.

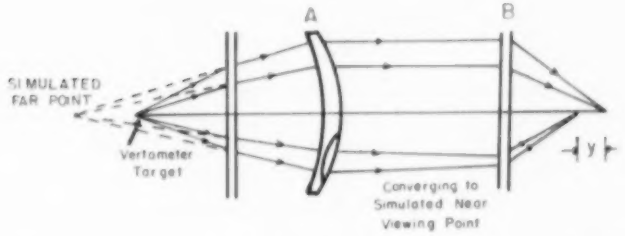

Fig. 3. When the vertometer is in adjustment for the measurement of the distance portion of a bifocal lens as shown in Fig. 2, rays coming from the vertometer target and passing through the near portion will converge to a point equivalent to the near viewing point. Hence they will not be brought to a focus by lens B in the same position as would parallel rays. This difference in position, y, is a measure of the true addition.

which is at a distance y from the corresponding point for the distance rays, i.e., the point they would converge to in the usual operation of the instrument. The distance y is a measure of the true addition of the bifocal, i.e., of the position of the near point which is conjugate to the patient's far point with respect to the near portion of the bifocals.

In practice, one way of achieving this is to attach the ocular in the vertometer to a rack so that it can be moved back and forth. The instrument can then be used with the bifocal lens in the usual position and a customary measurement of the back vertex power of the distance portion is obtained with the ocular remaining in the zero position. Then the vertometer target is viewed through the near portion of the bifocal lens and the ocular moved until the target becomes clear again. The addition is then read off an appropriate scale. If lens B of the vertometer is so mounted that the back vertex of the spectacle lens coincides with the principal focal point of lens B, the scale will be linear, i.e., the true addition A will be related to y by the expression $A = y F^2$, where F is the principal point power of lens B.

Another way of doing this is to mount a battery of lenses in front of lens B. After the usual determination of the back vertex power of the distance portion of the bifocal lens has been made, the near portion is moved into position and that lens of the battery selected which re-establishes a clear image of the target. Care has to be taken to calibrate the lenses in the battery properly, taking into account the distance between the position of the battery and the back vertex of the spectacle lens.

Such instruments could also be used in cases in which a proportion of the extra focal power required for the viewing of the designated near

point is provided by the patient's accommodation. In this case it would be necessary to bring the ocular to the position corresponding to the dioptral equivalent of the near viewing distance and then to move the vertometer target until a clear image results. The difference between the previously determined back vertex power of the distance portion and the new measurement would have to correspond to the spectacle accommodation which has to be exerted by the patient to see a point at the designated near viewing distance clearly through the near portion of the bifocals.

AMERICAN ACADEMY OF OPTOMETRY

CHAPTER ELECTION

The election of officers of the San Francisco Bay Area Chapter of the American Academy of Optometry was held at its meeting in Berkeley on the evening of November 10. The following officers were elected to serve during the 1956 year: Dr. Elwin Marg, chairman; Dr. Robert F. Harrigan, vice-chairman; Dr. Frederick W. Hebbard, secretary-treasurer. The officers and Dr. Kenneth B. Stoddard constitute the executive committee. Dr. Merton C. Flom was appointed chairman of the Chapter Committee on Admittance. The address of all above named officers is the School of Optometry, University of California, Berkeley.

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THE USE OF TECHNICIANS

At the recent national convention of the American Dental Association in San Francisco the association instructed its officers to launch an active nationwide campaign against the illegal practice of dentistry by dental technicians. In every State the association will demand strict enforcement of State dental practice laws which provide that only licensed dentists may administer dental treatment. Convention reports indicate that in many instances laboratory technicians have gone beyond the duties originally assigned to the group by the dentists who set up the training program for dental technicians.

This action on the part of the American Dental Association comes as no surprise. Dentists were pioneers in the development of technicians who have been trained to clean teeth, do routine X-ray photographic

work of the teeth and jaws and to assist the dentist in the operation of his laboratory. Not only have these technicians been trained to do many of the things originally required of dentists, but many of them have been certified and in some areas, licensed in their State to practice as dental technicians and assistants.

This dividing up of small areas of responsibility can in the long run cause endless disputes and hard feeling. While these technicians have no doubt done much good work in assisting dentists in their practices, the fact that they have received a certain degree of recognition and authority can easily bring about situations in which both the dentist and the technician feel their professional rights are being undermined by the other.

In its action at San Francisco the American Dental Association has pointed out a problem that will sooner or later face both optometrists and ophthalmologists. We, in the eye field, have also trained technicians. We have orthoptic technicians, contact lens technicians and dispensing technicians. Members of some of these groups have banded together into organizations and their spokesmen are demanding improved educational advantages, more recognition for their limited activities and legal certification. Where this will lead no one can say, but it is safe to predict that there will be some fireworks along the route.

In addition to the broad issues between practitioners and technicians these disputes also have the effect of disrupting normal intra-professional activities. The older practitioners with large well established practices are the men who hire technicians. The younger practitioners who are naturally less busy have no need of a technician. When younger men find that a technician is doing much of some older man's work, even under his personal supervision, experience shows that this breeds resentment and professional illwill. This division and hard feeling is a luxury no profession can afford.

Just where these issues will lead, no one at present knows. It is evident that dentistry is now facing these problems and perhaps doing so too late to adequately remedy the situation.

We, too, in the eye field must make some critical studies of our situation—as it affects the public and as it affects the optometrist—and in this way attempt to direct the future so that the use of technicians does not get out-of-hand. If our action is well thought out and vigorous we may still have time to guide these activities into the most satisfactory channels.

CAREL C. KOCH

SPECIAL REPORT

OPTOMETRY AND PROFESSIONALISM*

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As optometrists you are concerned with optometry in at least two ways that superficially appear to be quite different. You wish to see optometry become even more significant in public welfare than it is today and you wish it to provide a satisfactory way of life for you. Fortunately, these two achievements tend to go hand-in-hand.

What I will present is concerned with the relations of optometry to the public and in turn with gaining public understanding and support. I hope I can make a few suggestions without appearing to be unappreciative or critical of optometry. I assure you, to begin with, that I have found optometrists the very best group of men with which I have ever worked. I am proud of professional optometrists, and talk in their favor everywhere I go and every chance I get.

A number of things I shall say may not seem to pertain to what you can do much about. Despite any remoteness between my remarks and todays practice, I hope they will contain suggestions for a fruitful point of view.

The public is uninformed. It is a mass of people representing all degrees of intelligence and all kinds of outlook on life. As an example, various individuals and groups, within our society practice one or the other of eight different means for maintaining or regaining health. These are: (1) Divine intervention, (2) The use of drugs and surgery; (3) The regulation of diet; (4) The obtaining of physical conditions such as provided by various climates, etc.; (5) The dependence upon muscular exercises; (6) The relief of bodily stress, chiefly mechanical, as by manipulative therapy; (7) The achievement of right motor habits; and (8) Right thinking and outlook on life. You can picture for yourself some of the specific examples of these means of gaining health. You can also ask yourselves where optometry fits in. Some of these means have given rise to specific professions and

*An abridgment of the material presented before the Cleveland Optometric Association, Cleveland, Ohio, November 10, 1954. For publication in the December, 1955, issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.

†Ph.D., Professor of Psychology.

others have not. Some professions apply in one way or another several of these means. Suffice it to say, all of these means have been misused in various ways, for neither the public nor the advocates understand them well enough.

The public acts as a force in either promoting or hindering it's own welfare, and in either promoting or retarding those agencies that make for its own good. The legalization of professions is one of these agencies.

Before we go further, let us be clear as to what is meant by a profession. For us, a profession is a group of persons recognized and protected by law and public opinion as the only ones qualified to serve the public in certain specified ways, because of: (1) the seriousness of the services to the public: (2) the adequacy of the training and education received by the members of the group: and (3) the group's guaranty to safeguard the public by certain standards of licensure and a body of ethics.

From this, it may be seen, that six basic factors are involved in a profession, namely: (1) definition of the service area: (2) the implied uniqueness of the services within the area: (3) the seriousness to the public of the area covered by the services: (4) the need for special preparation by those rendering the services: (5) recognition, regard and protection of the group by the public through its laws: and (6) the protection of the public by the group through its acceptance of responsibility.

These constitute the formal arrangement under which a profession is established and maintained, but there are at least two additional factors involved in the fate of a profession. The first of these is especially operative when a profession is one of several having overlapping features. The first factor is the task of making the services of the profession more nearly unique. It must always be assumed that this is possible. There are at least two conceivable ways of bringing it about. One is improvement within the services currently being rendered. This is usually known as doing a better job, if not a different job. I think that optometrists are bent on doing this, and, here, no discussion is necessary. The second way that the profession can strive to become unique is to re-envisage the task to be done. It has been this problem that has attracted me to optometry, for I have heard much about matters with which no ophthalmologist concerns himself.

One or the other of two things seems to be true at this point. Either optometry is a practice that can almost solely be encompassed in optical terms, or else it is something beyond that. If it is but the

former, what is it that makes the profession different than that of ophthalmology, except for the medical and surgical aspects? If the optometrist is no different, and no better, what is the excuse for the separate profession? It is not an idle question. Optometrists must realize that other people ask such questions, and they must be given answers. The gist of what I am saying is, that intellectual efforts must be put forth to clarify the situation for all concerned.

I dare say, however, that few optometrists would base their claims exclusively on optics. Most optometrists feel that they are aware of something worth more to the patient than the services of any other eye man. It is this claim that needs to be implemented. It needs to be inspected in light of both the benefit it may be directly to the services rendered to the formulating of a clear picture for the public. I find, however, that there is apparently a great diversity in what even the optometrists conceived to be their profession, and their services to the patient.

The need for identity is made apparent by the closeness of optometry to two very different groups—the ophthalmologists, and certain groups in the public schools, interested in vision through reading problems. Hence, optometrists are not faced alone with distinguishing themselves from ophthalmologists. Optometry certainly has made a good start in distinguishing itself from ophthalmology, by asserting that vision is not simply a matter of inherited reflexes and a matter to be regarded solely in terms of inherent maturation and degeneration processes, but rather as a learned performance, over which the individual or rather those sophisticated in the matter can exercise some control.

This assertion has, however, taken optometry closer to the field of education than it has realized. As a consequence, optometry must be very alert as to the need for wise decisions from this point on.

One of the appropriate concerns of optometry is that of distinguishing its services from those of educators, and the public schools, in regard to slow readers and other problem cases in visual tasks. It is time that some attention be paid to whose job is to do what. Optometrists unite with workers in other disciplines in programs on child vision. The speakers from each domain read their papers and everybody seems pleased with the cooperation. I am not sure, however, what this is leading to, for no concern seems to be expressed for some reasonable division of tasks in visual training and therapy. The success may be to those who get there "fustist" and with the "mostest." But, perhaps the matter could be dealt with better if some serious and penetrating thought were to be given to what each discipline really has to

offer, and whose prerogatives it is to do what. We should be eager to see optometry fill as comprehensive and useful a role as possible in all things visual. But, if we fail to see the problem just stated, it would seem that in the end optometry may be precluded from carrying on certain services that it envisages as its own. Or, at least, it may be hampered by a curious kind of competition.

By now, assertions in regard to vision being a learned process are taken for granted, by a large number of optometrists. It is not nearly so certain that even those who believe that the principle of learning applies to vision have consistently followed out the implications of the assertion. Perhaps, some have not even tried to find out specifically just what the assertion implies. Accordingly, it is not too surprising that very few have done much to put into practice the implications.

I think, however, that it is incumbent upon those who profess to believe that vision is a learned process to see that they act accordingly. This involves a great deal. The idea should be the motivating force for a whole new line of research aimed at setting up specific hypotheses about various aspects of visual learning. We all should want to know in what ways and to what extent our notions are borne out in fact.

I should say, however, that it is a question as to whether the dictum that vision is a learned process is the very central notion in all optometry. This dictum may simply be a species of a still more general outlook in regard to the human organism.

It would be fortunate if optometry, in thought and research were to develop a thoroughgoing basis in general biology for the profession. Optometry made its beginning by doing a good job in optics. The recognition of the need for doing a better job in that respect has turned out to be a very beneficial thing for all. We are too prone to feel that what we have today is sufficient in principle, and needs only to be augmented by further detail.

In addition to the field of sense physiology of the mid-nineteenth century, psychology was the central area in which the study of vision was carried on. In more recent years with their economic low-tides and disasters of war, psychology began to see itself in the role of a service agency, a profession almost to the exclusion of being a science. This urge to help people has overshadowed psychology's function as a pure science in the biology group. Psychology is struggling assiduously to become a full-fledged profession. This has led to one consequence relevant here. It may lead to another, which if so, will be relevant to optometry in the future. The first consequence was the forsaking of the intensive study of perception and the sensory processes that had

characterized psychology's early history. This has left it to others to obtain the much needed facts and principles of vision that psychology might have been expected to provide.

The future possibility is that psychology will re-awaken to the study of perception and the sensory processes and try to make them an important ingredient in the practice of clinical psychology. Clinical psychology may claim as part of its domain the use of visual principles and practices involving them, which otherwise might become a part of optometry. That possibility is not very pressing now, but it is nevertheless one worth mentioning when the welfare and the future of optometry are being discussed. Stranger things than this have happened. In being ambitious for optometry, I am eager to see it become as insightful and as sagacious as possible in using all the facilities at its command for its own betterment and advantage. Keeping alert to the developments and trends in other areas, be they in science or in sister professions, is one of the ways of doing what has just been suggested.

Now, we arrive at the second of the two factors which I have already indicated has greatly to do with the fate of a profession. This factor is the profession's education of the public. The profession must achieve two things: It must gain the good will of the public, and it must be understood by the public. Being understood by the public consists in the public knowing how the profession views its task. It is well to keep in mind that the public consists not only in the myriads of ordinary people but also in leaders of thought in science and public affairs, whose influence at times is out of proportion to their numbers.

What I have already said in regard to the profession's development of advanced understandings of the human organism is relevant here. A profession must understand itself before it can portray itself to the public.

The education of the public is in part a process of self education. Just so long as optometrists do not reach the conclusion that they must inform the public about themselves and their profession, each optometrist, or each little group of them, can drift along in its own way and feel no discomfort in so doing. Each practitioner can feel that his methods and his practices are the preferable ones. An easy going self-satisfaction may well persist.

But once the profession sees that it must move toward making a unified front to the outside world, self-examination begins to take place, and some long-standing certainties may become uncertainties. The need to converge on one practice and profession of optometry rather than several distinct brands becomes apparent.

Optometry then has to become something that can be put into one

set of words, and not in a multiple set of descriptions regarding underlying rationale, practices, and objectives to be reached by the therapy employed.

It is not strange that the public knows all too little about human psychophysiology, and what to expect from its healers. First of all, there has been a lingering fear on the part of those not only in the healing arts but in all professions that the public will get to know too much for its own good. There has been the attitude of "just leave the job to us. We'll handled it." But this attitude has left the public a prey to any quack. Or, at least, it has given the average individual no sound basis for judging between the good and the bad within those professions practicing the healing arts.

In recent years, there have been attempts on the part of some of the healing arts to get the public into the doctor's offices at certain intervals for routine check-ups. This ought not to be the sole effort in what is called education of the public. There are certain things that the public ought to know. Let us at least change the general attitude from feeling that there is danger that people will get to know too much, and get to feeling that there is no such thing as too much genuine information. I believe that if the various healing arts would take this stand, the public schools might be made to serve much better in giving the general information on which adult education could be based.

Actually, physicians seem to be changing somewhat in this respect. For example, in some cities, public forums are scheduled. In these the public is given answers to their questions regarding diseases that concern them. This, however, is only a start in the direction indicated. The public needs to know at least seven things about eye-care and the professions that provide it.

(1) The public needs to know what a true profession is and what its relations to the public ought to be. Professionalism ought to be more than an empty word.

(2) The public should be made aware of the unique contribution of optometry. In this connection, as has already been discussed, optometry should see to it that it has a good unified description to give, and that the role played by optometry becomes more and more significant, thus providing the basis for a unique description.

(3) The public should understand that the licensing laws in many states are still so lax that those not adequately trained and professionally motivated are permitted to examine patients, write prescriptions and practice all the techniques having to do with eye-care. Implied in the understanding is the attitude that would boycott non-

professional practitioners. This applies to optometrists as well as others.

(4) The public needs to know something of the proper relations between patient and doctor including the possession of appropriate knowledge about the writing and handling of prescriptions. This involves the realization that there is often a dependent group, that of opticianry, involved. The public should know that it is not always possible for professional men to agree to wishes that are dictated by commercial considerations. Professions, unlike other groups, have certain specified responsibilities.

(5) The public needs to know a great deal more about the very common features of the visual mechanism including the fact that vision involves not only optical but muscular, neural and higher order processes of the organism.

(6) This leads us to the fact that it would be good for the public to realize that there is a distinction between ocular disease and the inability to see well or to manifest low visual skills.

(7) The public needs to know more about visual training than it does. Optometrists are not happy about the procedures that constitute the Bates system. A way must be found to indoctorinate the public on the distinction between Batesism and visual training. If that distinction cannot be put into clear words, do not be surprised if the public does what you do not want it to do.

The traditional logic has been that if the patients would just go to the right eye man they would not have to be versed in any of the principles regarding the therapy used.

This logic does not solve the problem of getting patients to the right eye men. Criteria must be in the hands of the patients themselves, and those criteria are not just hearsay recommendations such as that so-and-so liked such-and-such a doctor. Actual background knowledge about human physiology, etc., is indispensable.

Ways must be found to develop an active program in visual education. How this is to be done is a matter that comes only after the profession is fully certain that it could be done and it is eager to do it.

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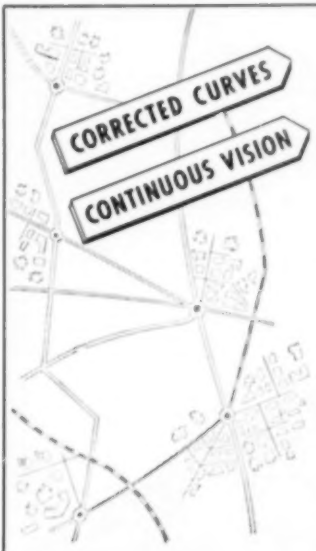

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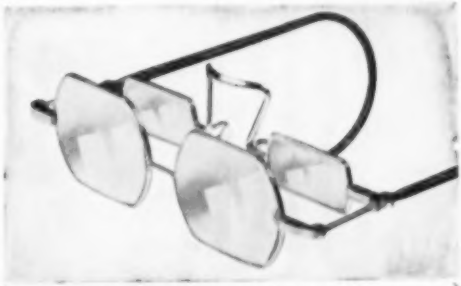

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